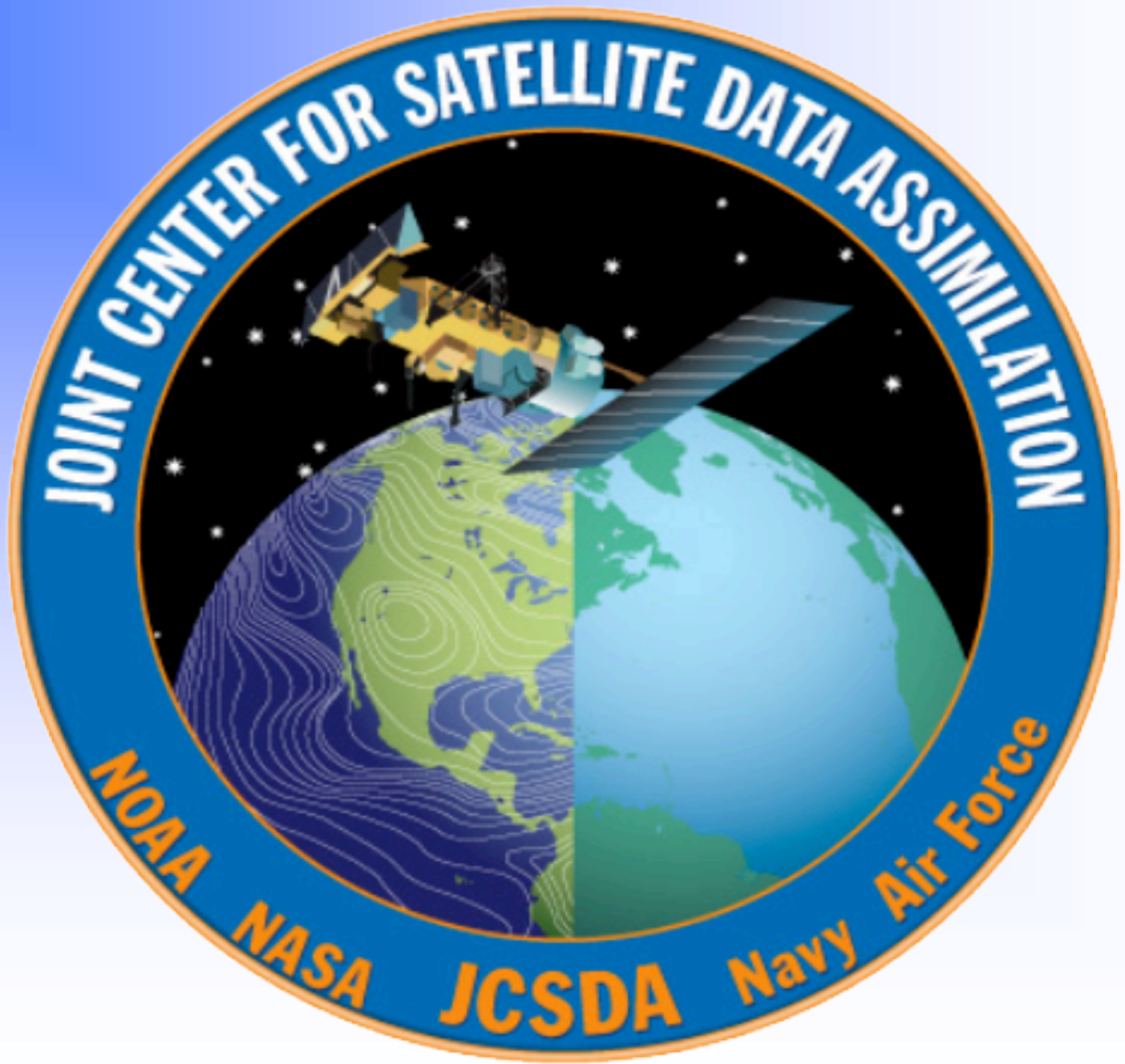
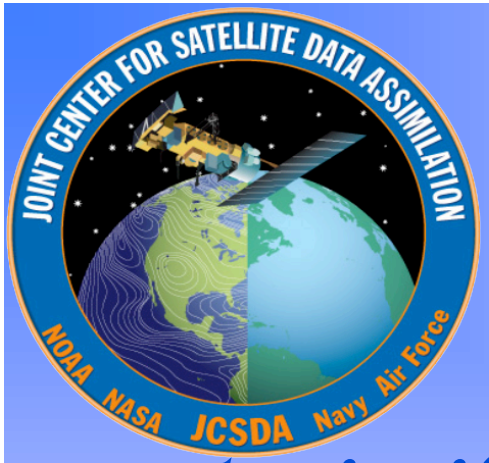

JOINT CENTER FOR SATELLITE DATA ASSIMILATION
NOAA
NASA
JCSDA
Navy
Air Force

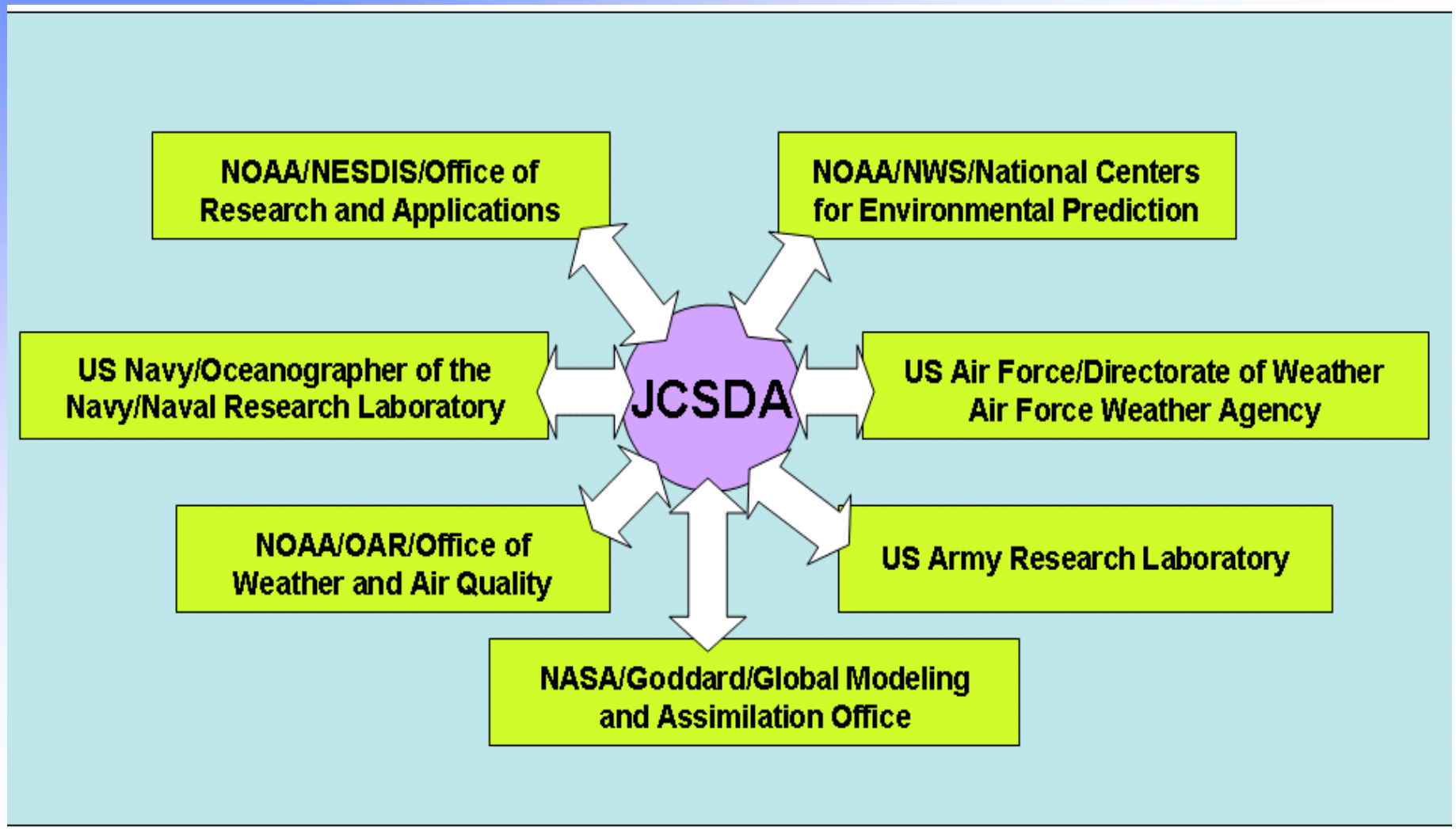


Assimilation of Advanced InfraRed Sounder (AIRS) observations at the JCSDA

J. Le Marshall*, J. Jung, J. Derber, R. Treadon,
M. Goldberg, W. Wolf and T. Zapotocny

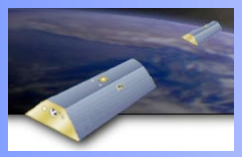
John Le Marshall,
JCSDA

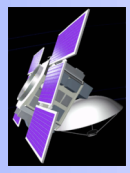
JCSDA
Joint Center for Satellite Data Assimilation



The Challenge
Satellite Systems/Global Measurements

GRACE



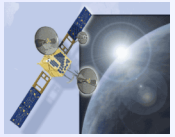


Cloudsat

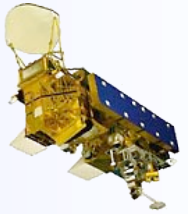
CALIPSO

SSMIS

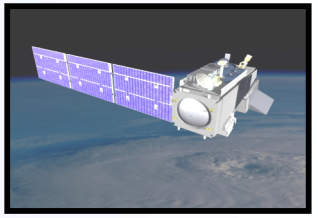
TRMM



GIFTS

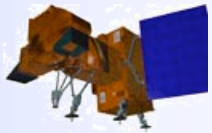


Aqua



NPP

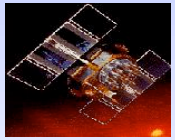
TOPEX



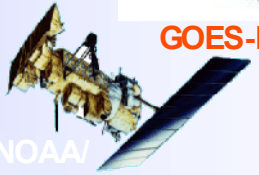
Landsat

Meteor/
SAGE

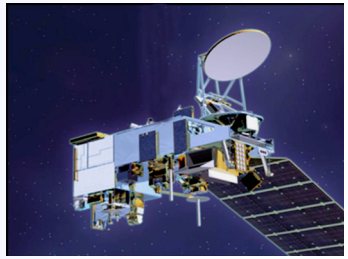
GOES-R



COSMIC/GPS

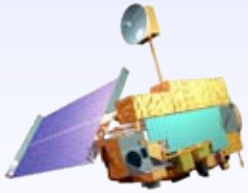


NOAA/
POES

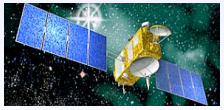


NPOESS

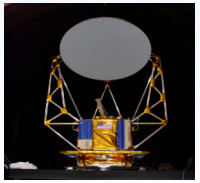
SeaWiFS



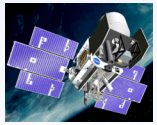
Terra



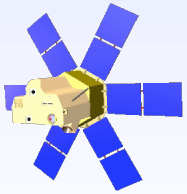
Jason



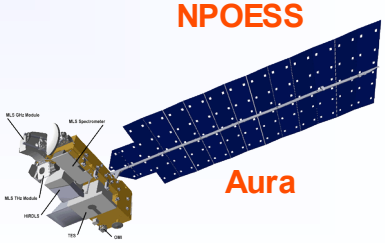
Windsat



ICESat



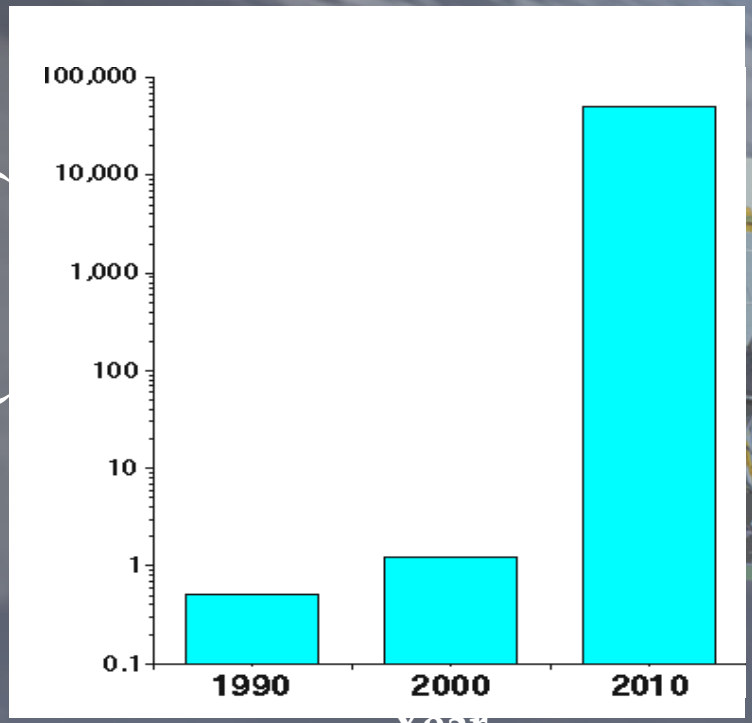
SORCE



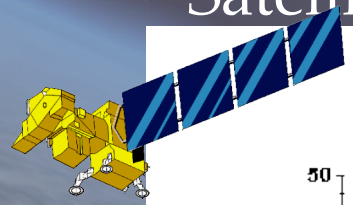
Aura

5-Order Magnitude increase in satellite Data Over 10 Years

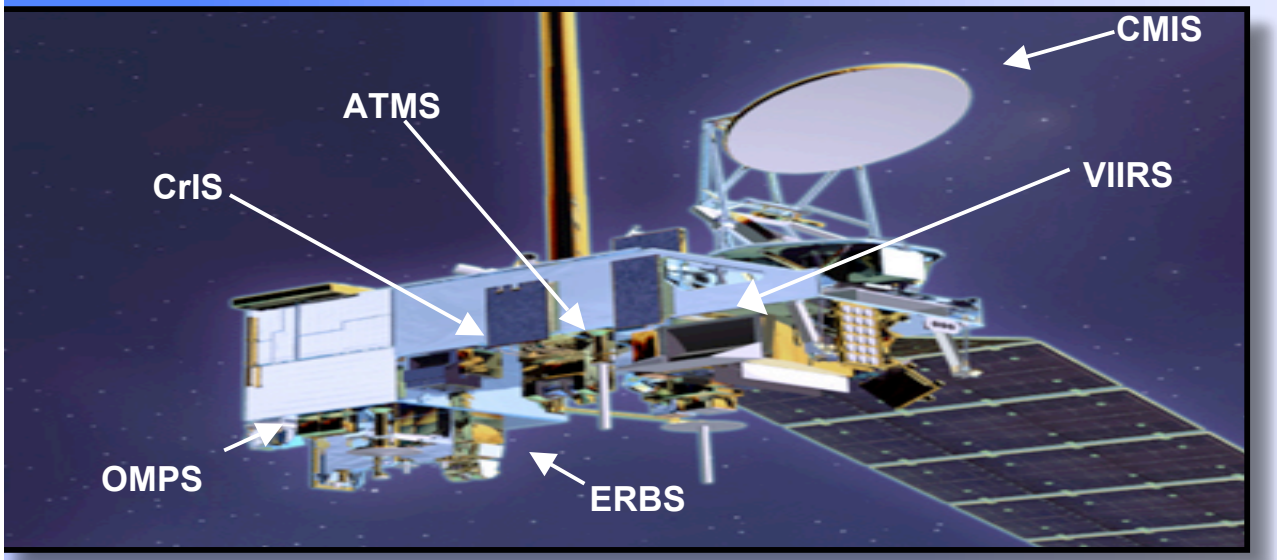
Daily Upper Air Observation Count



Satellite Instruments by Platform



NPOESS Satellite



CMIS- µwave imager
VIIRS- vis/IR imager
CrIS- IR sounder
ATMS- µwave sounder
OMPS- ozone
GPSOS- GPS occultation
ADCS- data collection
SESS- space environment
APS- aerosol polarimeter
SARSAT - search & rescue
TSIS- solar irradiance
ERBS- Earth radiation budget
ALT- altimeter
SS- survivability monitor

The NPOESS spacecraft has the requirement to operate in three different sun synchronous orbits, 1330, 2130 and 1730 with different configurations of fourteen different environmental sensors that provide environmental data records (EDRs) for space, ocean/water, land, radiation clouds and atmospheric parameters.

In order to meet this requirement, the prime NPOESS contractor, Northrop Grumman Space Technology, is using their flight-qualified NPOESS T430 spacecraft. This spacecraft leverages extensive experience on NASA's EOS Aqua and Aura programs that integrated similar sensors as NPOESS.

As was required for EOS, the NPOESS T430 structure is an optically and dynamically stable platform specifically designed for earth observation missions with complex sensor suites.

In order to manage engineering, design, and integration risks, a single spacecraft bus for all three orbits provides cost-effective support for accelerated launch call-up and operation requirement changes. In most cases, a sensor can be easily deployed in a different orbit because it will be placed in the same position on the any spacecraft. There are ample resource margins for the sensors, allowing for compensation due to changes in sensor requirements and future planned improvements.

The spacecraft still has reserve mass and power margin for the most stressing 1330 orbit, which has eleven sensors. The five panel solar array, expandable to six, is one design, providing power in the different orbits and configurations.

GOES - R

ABI – Advanced Baseline Imager

HES – Hyperspectral Environmental Suite

SEISS – Space Environment In-Situ Suite including the Magnetospheric Particle Sensor (MPS); Energetic Heavy Ion Sensor (EHIS); Solar & Galactic Proton Sensor (SGPS)

SIS – Solar Imaging Suite including the Solar X-Ray Imager (SXI); Solar X-Ray Sensor (SXS); Extreme Ultraviolet Sensor (EUVS)

GLM – GEO Lightning Mapper

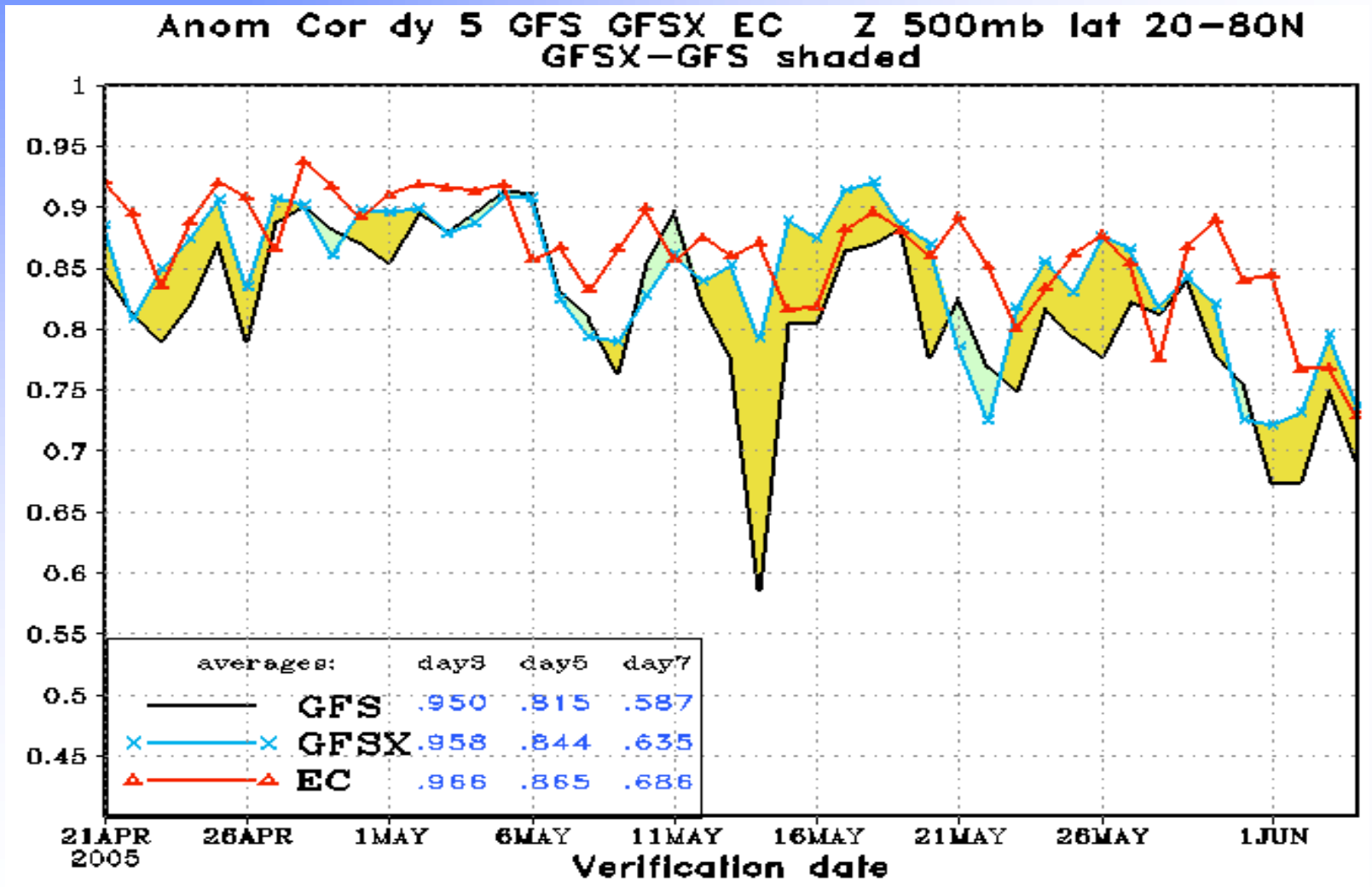
Satellite Data used in NWP

- HIRS sounder radiances
- AMSU-A sounder radiances
- AMSU-B sounder radiances
- GOES sounder radiances
- GOES, Meteosat, GMS winds
- GOES precipitation rate
- SSM/I precipitation rates
- TRMM precipitation rates
- SSM/I ocean surface wind speeds
- ERS-2 ocean surface wind vectors
- QuikScat ocean surface wind vectors
- AVHRR SST
- AVHRR vegetation fraction
- AVHRR surface type
- Multi-satellite snow cover
- Multi-satellite sea ice
- SBUV/2 ozone profile and total ozone
- Altimeter sea level observations (ocean data assimilation)
- AIRS radiances
- MODIS Winds…

Sounding data used operationally within the GMAO/NCEP Global Forecast System

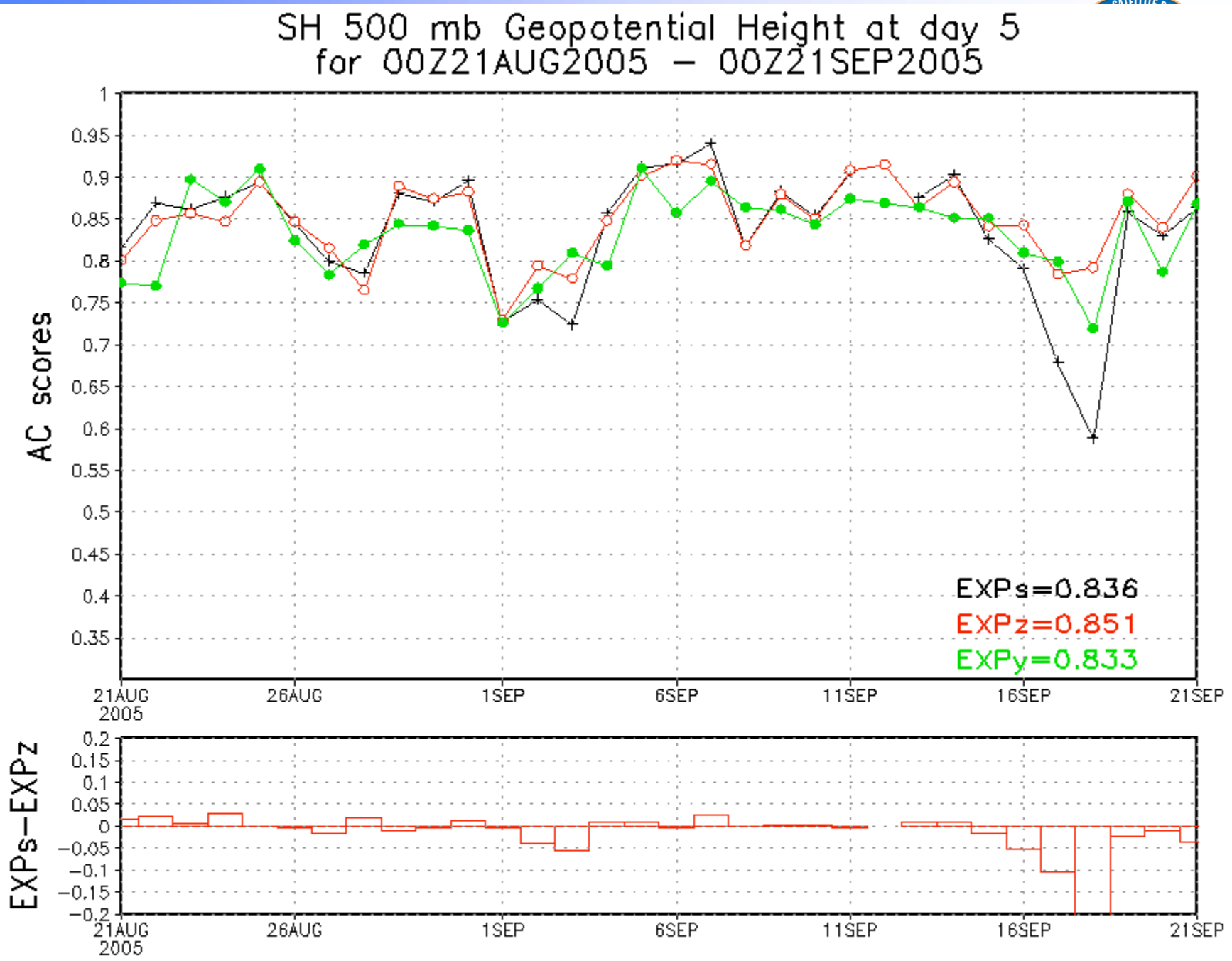
AIRS	On
HIRS sounder radiances	14 - on 15 - off 16 - off 17 - on
AMSU-A sounder radiances	15 - on 16 - on 17 - off 18 - on AQUA
MSU AMSU-B sounder radiances	14 - on 15 - on 16 - on 17 - on
GOES sounder radiances	10 - on 12 - on
SBUV/2 ozone profile and total ozone	16 - on 17 - on

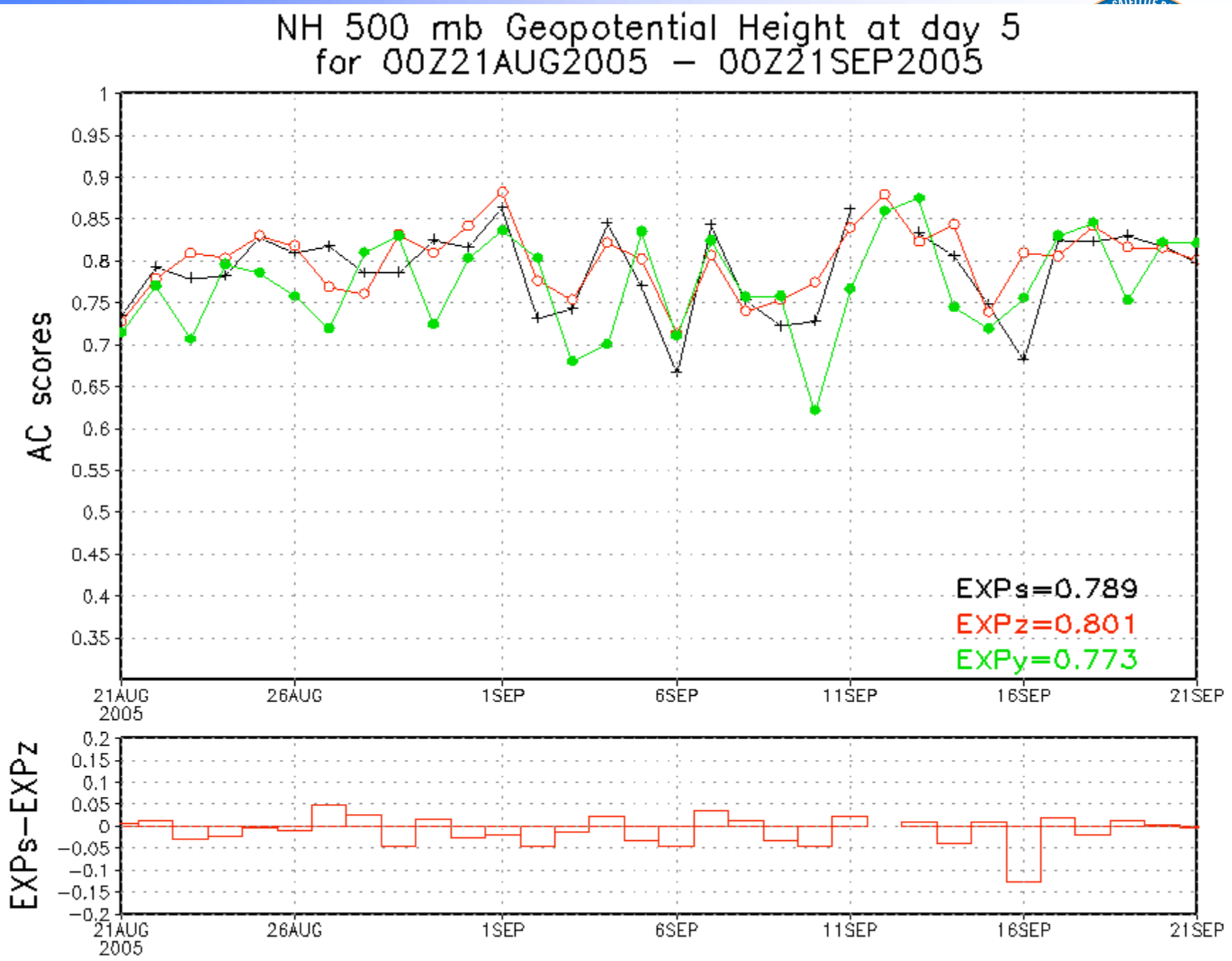
Yellow shaded areas indicate improved forecasts by the new NCEP Global Forecast System (GFSX-blue) compared to the old system (GFS-black). The gap between accuracies of NCEP and ECMWF (EC-red) forecasts is halved with the new system.NOAA18 AMSU,MODIS AMVs, AIRS thk. SSM/I still being added.



SATELLITE DATA – STATUS Fall 2005

AIRS v1.	Implemented
AIRS v2.	Completed Operational Trial - NCO
MODIS Winds	Completed Operational Trial - NCO
NOAA-18 AMSU-A	Completed Operational Trial - NCO
NOAA-18 MHS	Completed Operational Trial - NCO
NOAA-17 SBUV Total Ozone	Completed Operational Trial - NCO
NOAA-17 SBUV Ozone Profile	Completed Operational Trial - NCO
SSM/I Radiances	Operational Trial with GSI compl. (prod. now used)
COSMIC/CHAMP	Testing Assim. System
SSMIS	Quality Control and Data Selection being Finalized
MODIS Winds v2.	RT Testing
WINDSAT	Wind Vector Assimilation - Active
AMSR/E – Radiance Assimilation	Test and Development
AIRS/MODIS Sounding Channels Assim.	Data in Preparation
GOES – SW Winds	To be Tested
GOES Hourly Winds	To be Tested
GOES 11 and 12 Clear Sky Rad. Assim(6.7μm)	To be Tested
MTSAT 1R Wind Assim.	Data in Preparation
AURA OMI	Test and Development
TOPEX,JASON1,ERS-2 ENVISAT ALTIMETER	Test and Development, Ops 06 GODAS
FY – 2C	Data in Preparation


SH 500 mb Geopotential Height at day 5
for 00Z21AUG2005 – 00Z21SEP2005
AC scores
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
EXPs=0.836
EXPz=0.851
EXPy=0.833
21AUG
2005
26AUG
1SEP
6SEP
11SEP
16SEP
21SEP
EXPs–EXPz
0.2
0.15
0.1
0.05
0
–0.05
–0.1
–0.15
–0.2
21AUG
2005
26AUG
1SEP
6SEP
11SEP
16SEP
21SEP


NH 500 mb Geopotential Height at day 5
for 00Z21AUG2005 – 00Z21SEP2005
AC scores
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
EXPs=0.789
EXPz=0.801
EXPy=0.773
21AUG
2005
26AUG
1SEP
6SEP
11SEP
16SEP
21SEP
EXPs–EXPz
0.2
0.15
0.1
0.05
0
–0.05
–0.1
–0.15
–0.2
21AUG
2005
26AUG
1SEP
6SEP
11SEP
16SEP
21SEP

CURRENT SATELLITE DATA - STATUS

AIRS v1.	Implemented
AIRS v2.	Completed Operational Trial - NCO
MODIS Winds	Implemented
NOAA-18 AMSU-A	Implemented
NOAA-18 MHS	Completed Operational Trial - NCO
NOAA-17 SBUV Total Ozone	Implemented
NOAA-17 SBUV Ozone Profile	Implemented
SSM/I Radiances	Operational Trial with GSI -Impl. (prod. now used)
COSMIC/CHAMP	Assim. System Complete
SSMIS	Quality Control and Data Selection being Finalized
MODIS Winds v2.	RT Testing
WINDSAT	Wind Vector Assimilation - Active
AMSR/E – Radiance Assimilation	Test and Development
AIRS/MODIS Sounding Channels Assim.	Active
GOES – SW Winds	To be Tested
GOES Hourly Winds	To be Tested
GOES 11 and 12 Clear Sky Rad. Assim(6.7μm)	To be Tested
MTSAT 1R Wind Assim.	Data in Preparation
AURA OMI	Test and Development
TOPEX,JASON1,ERS-2 ENVISAT ALTIMETER	Test and Development, Ops 06 GODAS
FY – 2C	Data in Preparation

Satellite Instruments and Their Characteristics (* = currently assimilated in NWP) - Feb. 200

Primary Inform

Platform	Instrument (Used in NWP*)	Status	Temper-ature	Humidity	Cloud	Precip-itation	Wind	Ozone
DMSP	F-13	Current						
	SSM/I *			√	√	√	√	
	SSM/T		√					
	SSM/T-2			√		√		
	F-14	Current						
	SSM/I *			√	√	√	√	
	SSM/T		√					
	SSM/T-2			√		√		
	F-15	Current						
	SSM/I *			√	√	√	√	
	SSM/T		√					
	SSM/T-2			√		√		
	F-16	Current						
	SSM/T		√					
	SSM/T-2			√		√		
	SSMI/S							
	OLS				√			
POES	NOAA-14	Current						
	MSU*		√	√	√	√		
	HIRS/2 *		√	√	√			√
	AVHRR *				√			
	SBUV/2 *							√
	SEM							
	DCS							
	SARSAT							
	NOAA-15	Current						
	AMSU-A *		√	√	√	√		
	AMSU-B *			√		√		
	HIRS/3 *		√	√	√			√
	AVHRR/3 *				√			
	SEM/2							
	DCS							
	SARSAT							

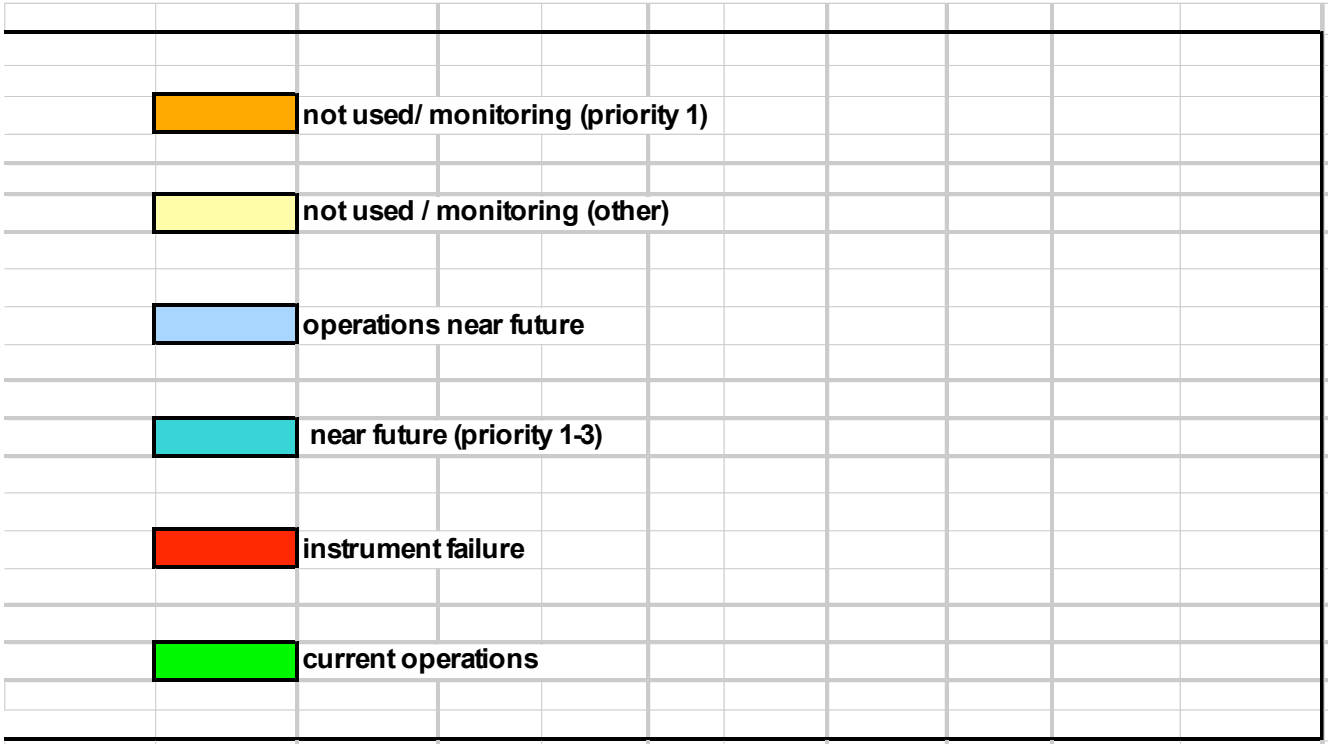
Satellite Instruments and Their Characteristics (* = currently assimilated in NWP) - Feb. 2006

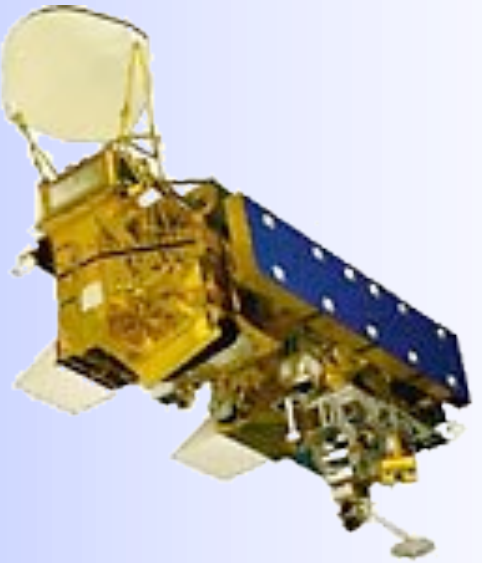
			Primary Information Content								
Platform	Instrument (Used in NWP*)	Status	Temper-ature	Humidity	Cloud	Precip-itation	Wind	Ozone	Land Surface	Ocean Surface	Aerosols
	NOAA-16	Current									
	AMSU-A *		√	√	√	√			√	√	
	AMSU-B *			√		√					
	HIRS/3 *		√	√	√			√	√	√	
	AVHRR/3 *				√				√	√	√
	SBUV/2 *							√			
	SEM/2										
	DCS										
	SARSAT										
	NOAA-17	Current									
	AMSU-A *		√	√	√	√			√	√	
	AMSU-B *			√		√					
	HIRS/3 *		√	√	√			√	√	√	
	AVHRR/3*				√				√	√	√
	SBUV/2 *							√			
	SEM/2										
	DCS										
	SARSAT										
	NOAA-18	Current									
	AMSU-A *		√	√	√	√			√	√	
	AVHRR *				√				√	√	√
	SBUV *							√			
	HIRS/4		√	√	√			√	√	√	
	MHS			√	√	√			√		

Satellite Instruments and Their Characteristics (* = currently assimilated in NWP) - Feb. 2006

			Primary Information Content									
Platform	Instrument (Used in NWP*)	Status	Temper-ature	Humidity	Cloud	Precip-itation	Wind	Ozone	Land Surface	Ocean Surface	Aerosols	Earth Radiation Budget
GOES	Imager *	Current										
	Sounder *		√	√	√		√		√	√		
GFO	Altimeter	Current					√			√		
MTSAT	Imager *	Current	√	√	√		√		√	√	√	
Terra	MODIS*	Current	√	√	√	√	√		√	√	√	
TRMM	TMI	Current		√	√	√	√		√	√		
	VIRS				√					√	√	
	PR					√						
	CERES											√
QuikSCAT	Scatterometer *	Current					√		√			
TOPEX	Altimeter *	Current		TPW			√			√		
JASON-1	Altimeter*	Current		TPW			√			√		
AQUA	AMSR-E	Current		√	√	√	√		√	√		
	AMSU*		√	√	√	√			√	√		
	HSB			√		√				√		
	AIRS*		√	√	√			√	√	√		
	MODIS*		√	√	√	√	√		√	√	√	
Envisat	Altimeter	Current		√		√	√			√		
	MWR			√	√							
	MIPAS		√					√				
	AATSR									√		
	MERIS				√				√	√	√	
	SCIAMACHY			√	√			√			√	
	GOMOS							√				
Windsat	Polarimetric radiometer	Current	SST	TPW		√	√		√	√		
Aura	OMI	Current						√				
	MLS							√				

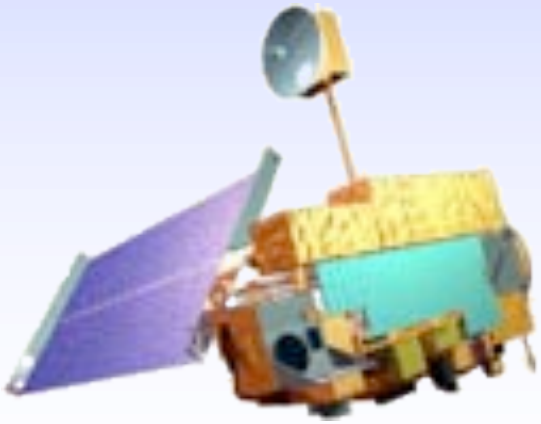
Platform	Instrument (Used in NWP*)	Status	Temper-ature	Humidity	Cloud	Precip-itation	Wind	Ozone	Land Surface	Ocean Surface	Aerosols
INSAT-3D	Imager	2007		√	√	√	√		√	√	√
	Sounder		√	√	√		√		√	√	
FY-1		Current	√	√	√	√	√			√	√
FY-2		Current		√	√		√		√	√	√
CHAMP	GPS	Current	√	√							
COSMIC	GPS	2005	√	√							
METOP	IASI	2006	√	√	√			√	√	√	
	ASCAT						√		√	√	
	GRAS		√	√							
	HIRS		√	√	√			√	√	√	
	AMSU		√	√	√	√			√	√	
	MHS			√		√					
	GOME-2							√			
	AVHRR		SST		√	√			√	√	√
NPP	VIIRS	2008	SST		√		Polar		√	√	√
	CRIS		√	√	√			√	√	√	
	OMPS										
	ATMS		√	√	√	√			√	√	
EO-3/IGL	GIFTS	2009	√	√	√	√	√	√	√	√	
SMOS	MIRAS	2007							√	√	
NPOESS	VIIRS	2009	SST	TPW	√		Polar		√	√	√
	CRIS		√	√	√			√	√	√	
	ATMS		√	√	√	√			√	√	
	CMIS		√	√	√	√	√		√	√	
	GPSOS		√	√							
	APS										√
	ERBS										
	Altimeter						√			√	
	OMPS							√			
ADM	Doppler lidar	2009					√				
GPM	GMI	2010				√	√		√		
	DPR					√					
GOES R	ABI	2012			√	√	√		√	√	√
	HES		√	√	√		√	√	√	√	


not used/ monitoring (priority 1)
not used / monitoring (other)
operations near future
near future (priority 1-3)
instrument failure
current operations



JCSDA

RECENT ADVANCES



IMPROVED COMMUNITY RADIATIVE TRANSFER MODEL (CRTM)

Currently V.0 used operationally in SSI

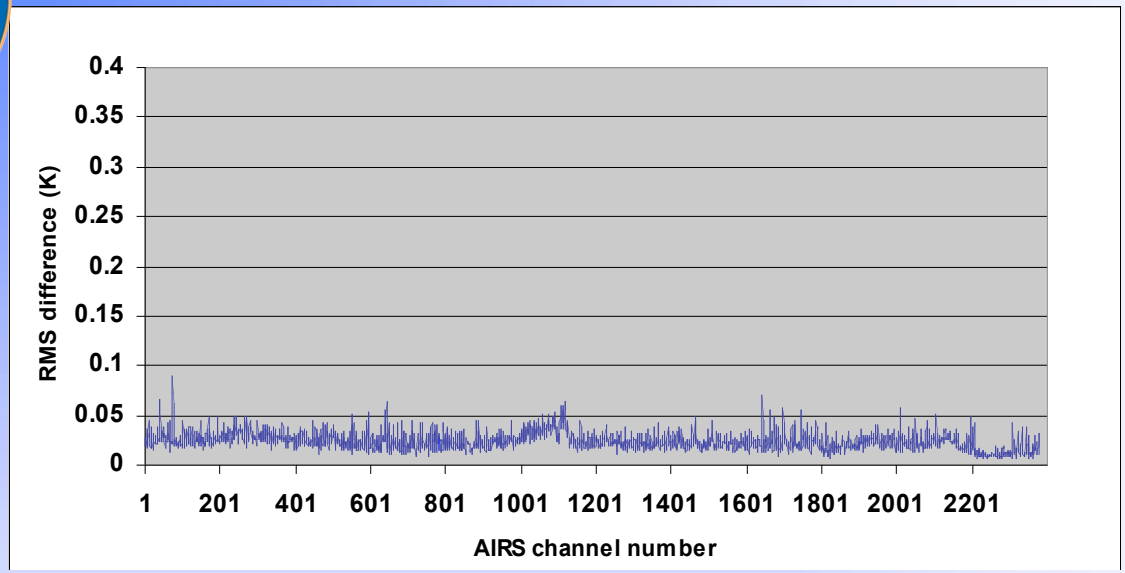
V.1 implemented into new GSI

-improved modeling of surface
-cloud scattering IR/MW
-placeholder for IR aerosol code

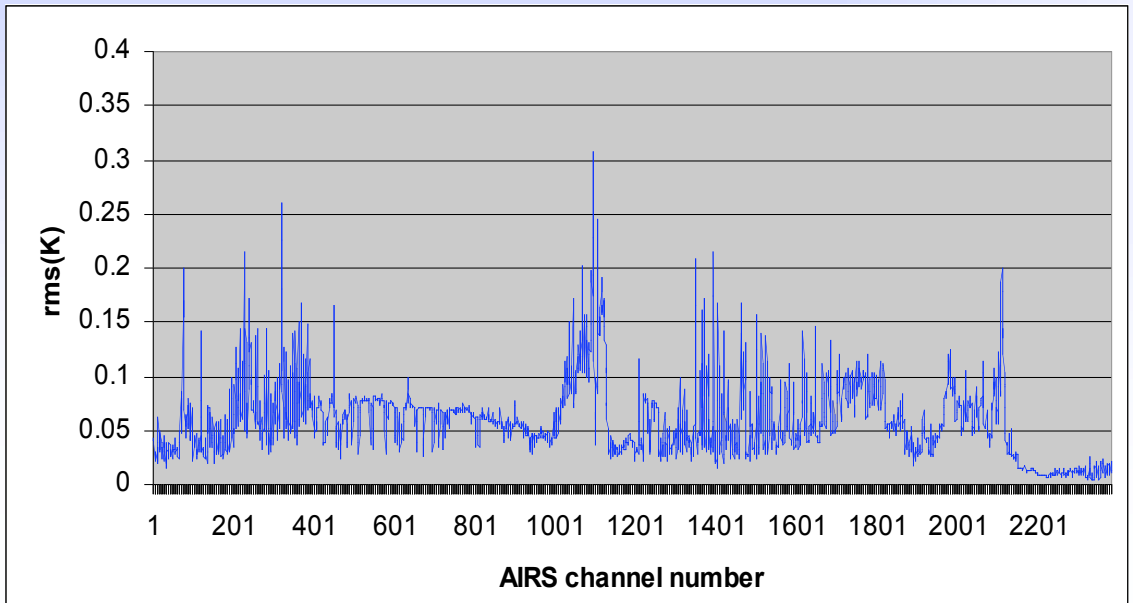
V.2 under test – includes OSS

IMPROVED COMMUNITY RADIATIVE TRANSFER MODEL

CRTM OPTRAN-V7 vs. OSS at AIRS channels



OSS



OPTRAN

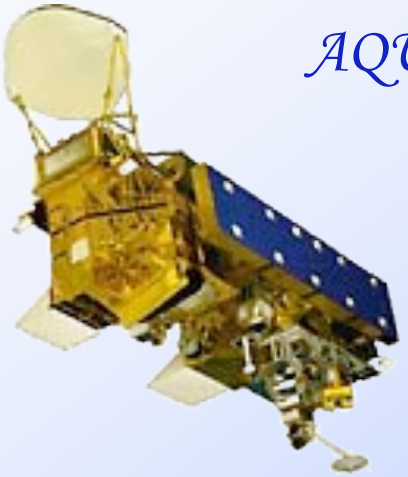
Computation & Memory Efficiency

Time needed to process 48 profiles with 7 observation angles

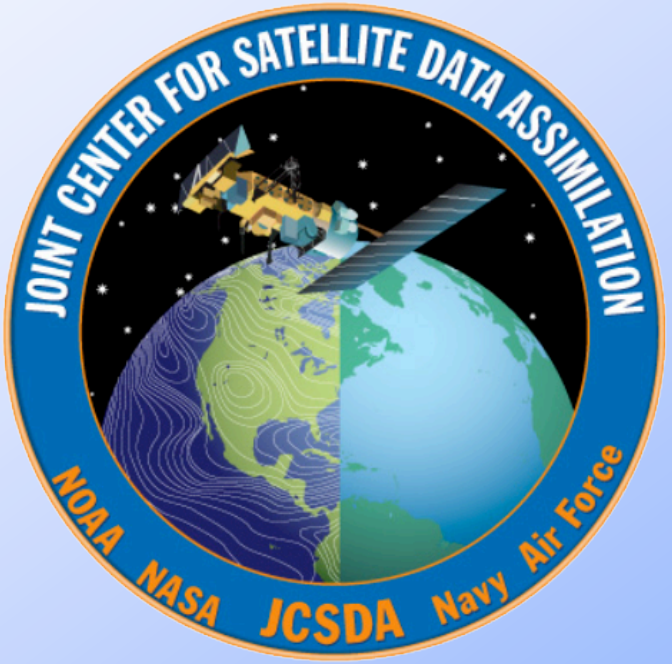
	OPTRAN-V7 Forward, Jacobian+Forward	OPTRAN-comp Forward, Jacobian+Forward	OSS Jacobian+Forward
AIRS	7m20s, 22m36s	10m33s, 35m12	3m10s
HIRS	4s, 13s	5s, 17s	9s

Memory resource required (Megabytes)

	OPTRAN-V7 single, double	OPTRAN-comp double precision	OSS Single precision
AIRS	33, 66	5	97
HIRS	0.26, 0.5	0.04	4



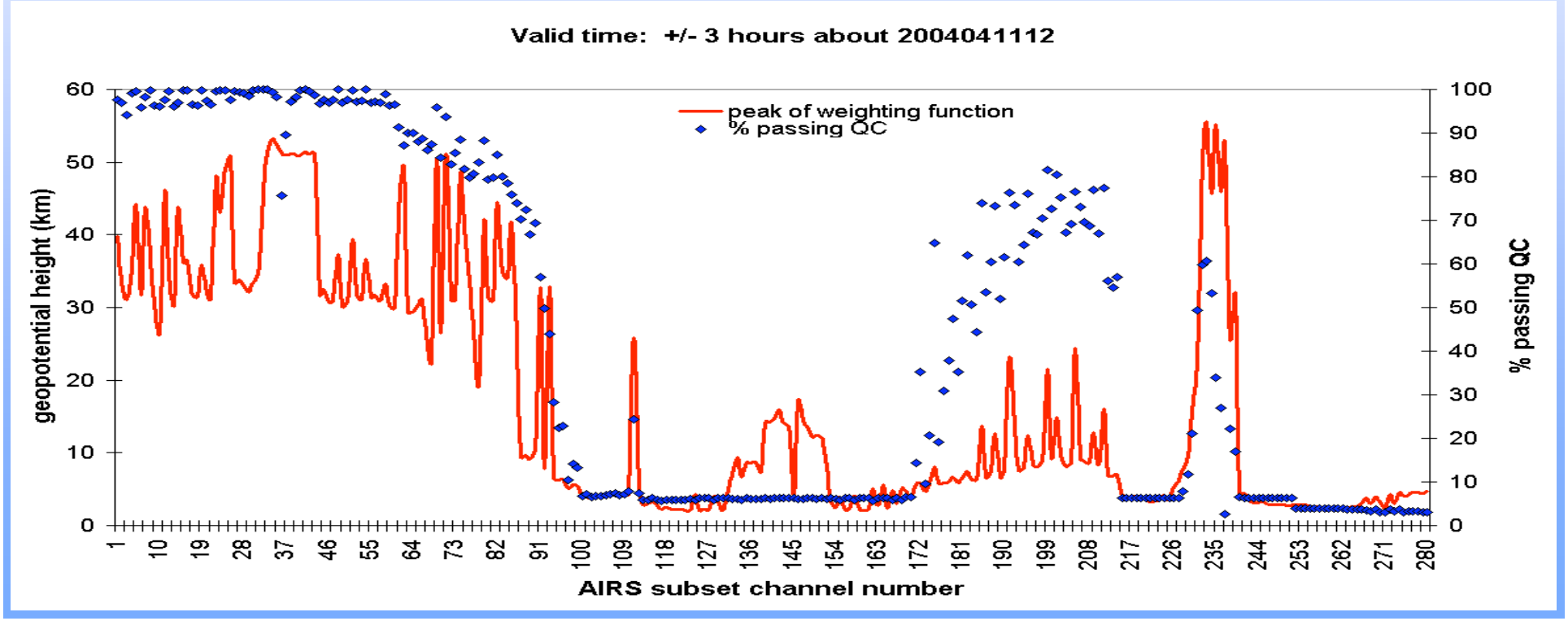
AQUA



Hyperspectral Data Assimilation

SSI modifications

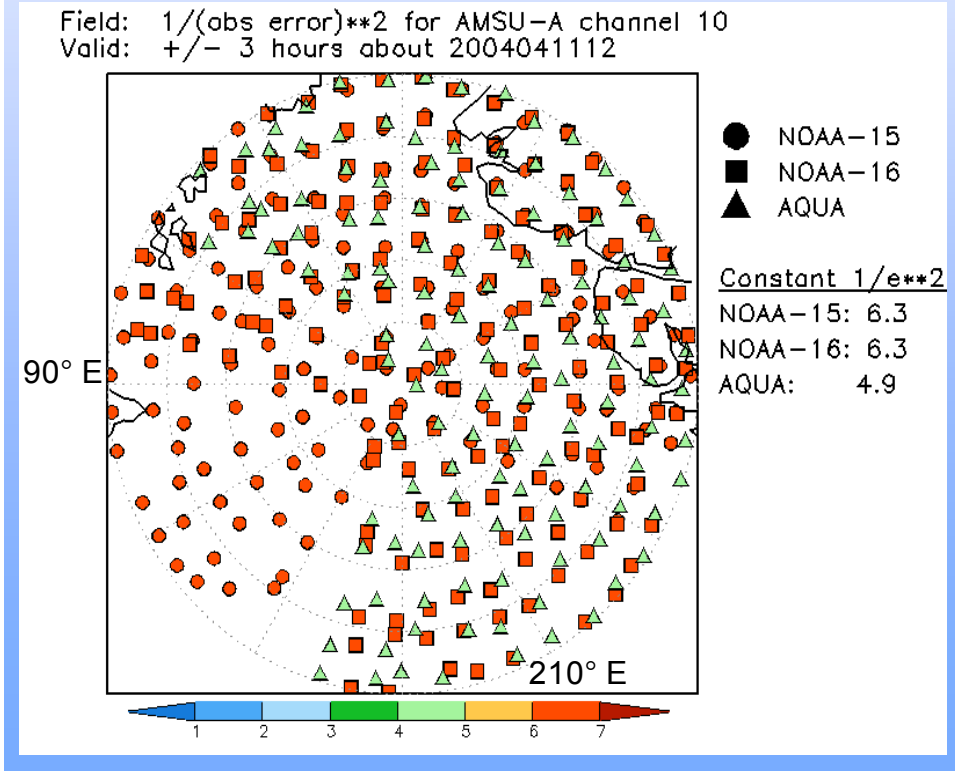
- conservative detection of IR cloudy radiances
  - examine sensitivity, δT_b, of simulated T_b to presence of cloud and skin temperature
  - those channels for which δT_b exceeds an empirical threshold are not assimilated



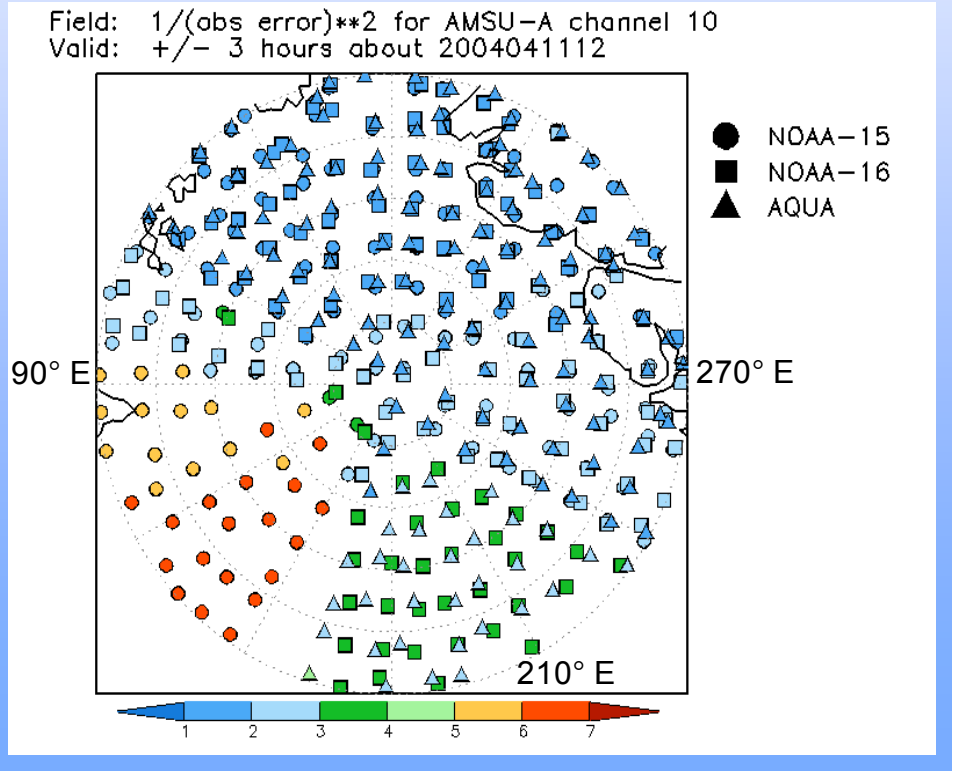
SSI modifications

- more flexible horizontal thinning/weighting
  - account for sensors measuring similar quantities
    - specify sensor groupings (all IR, all AMSU-A, etc)
    - specify relative weighting for sensors within group

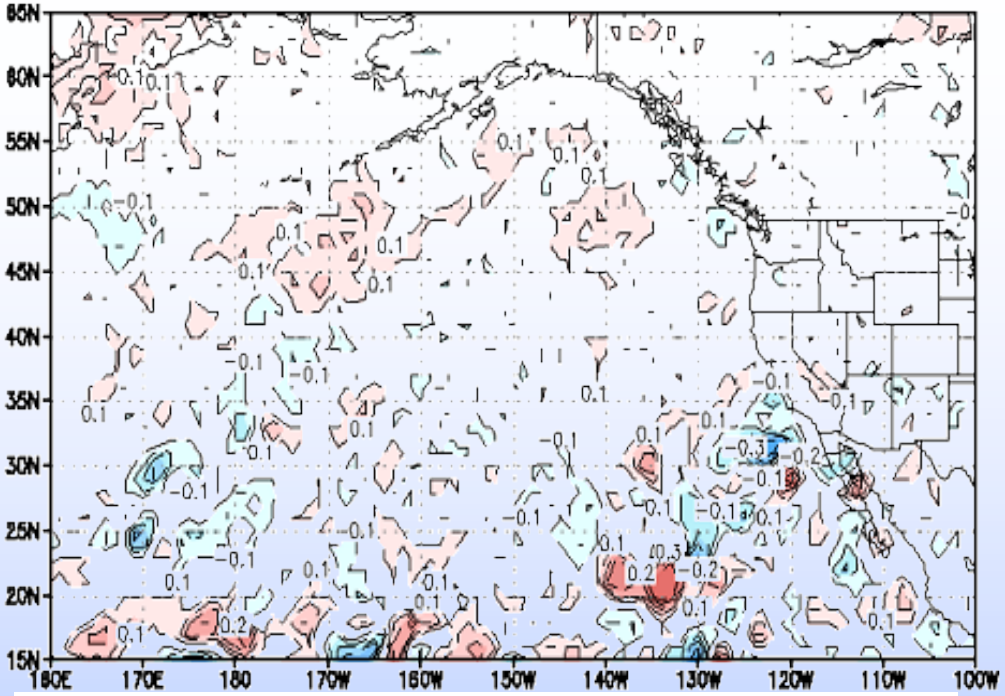
Old thinning/weighting

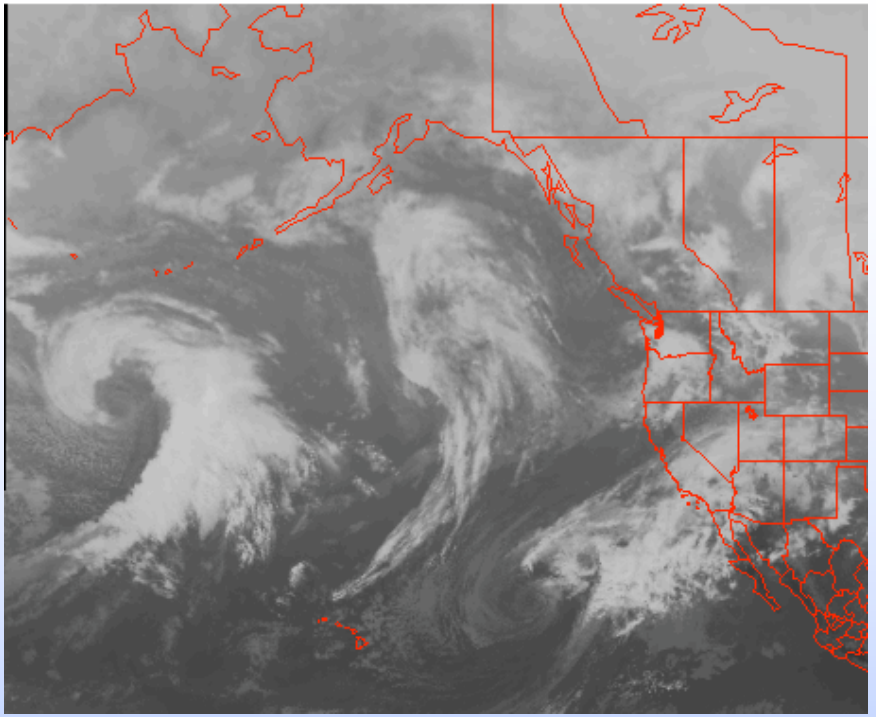


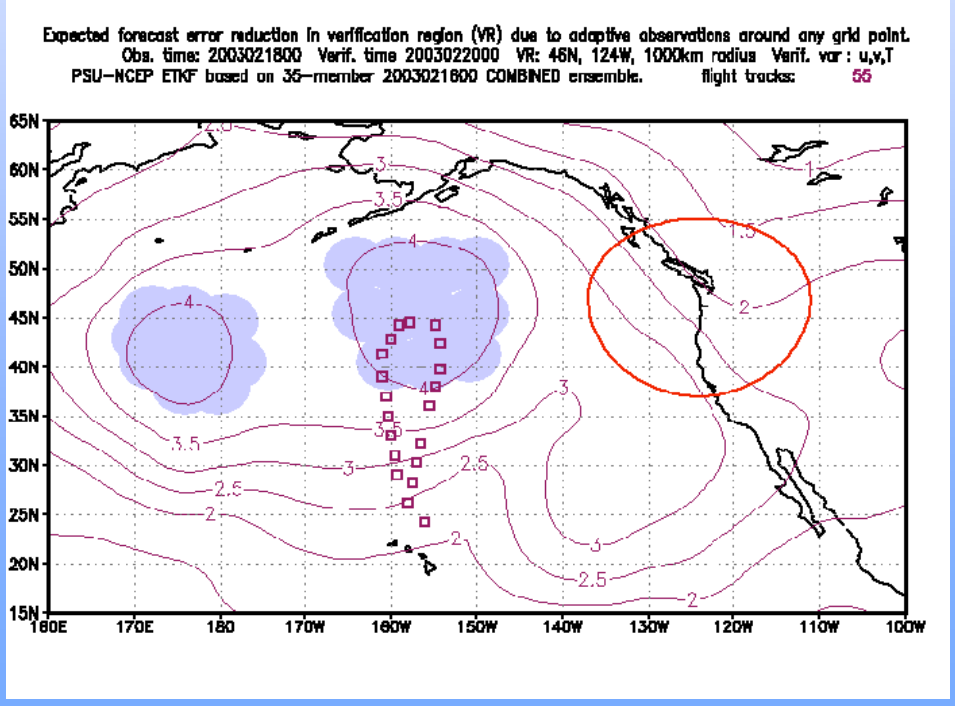
New thinning/weighting



Sensitivity (Targeting) Studies







Data Impact of AIRS on 500 hPa Temperature (top left), IR Satellite Image (top right), and estimated sensitivity (left) for 18 Feb 2003 at 00 UTC

Impact outside the targeted areas is due to small differences between the first guess forecasts. Sensitive areas show no data impact due to cloud coverage.

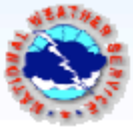
- Light purple shading indicates AIRS data selection
- Violet squares indicate dropsonde locations
- Red ellipse shows verification region

Assimilation of advanced sounders at NCEP

John C. Derber, Russ Treadon, and Paul VanDelst

NOAA/NWS/NCEP/EMC

28 June 2004

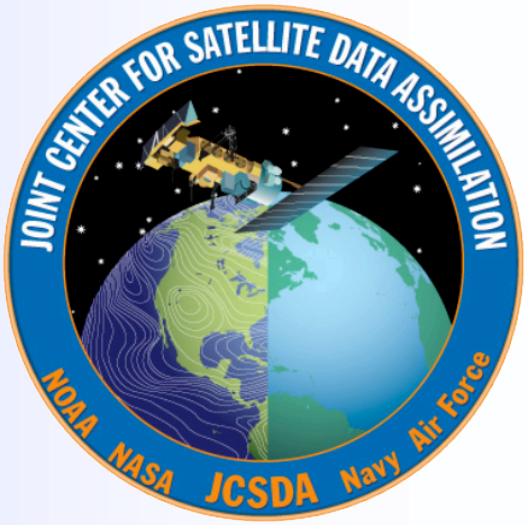


ECMWF workshop on Assimilation of high spectral resolution sounders

AQUA impact studies

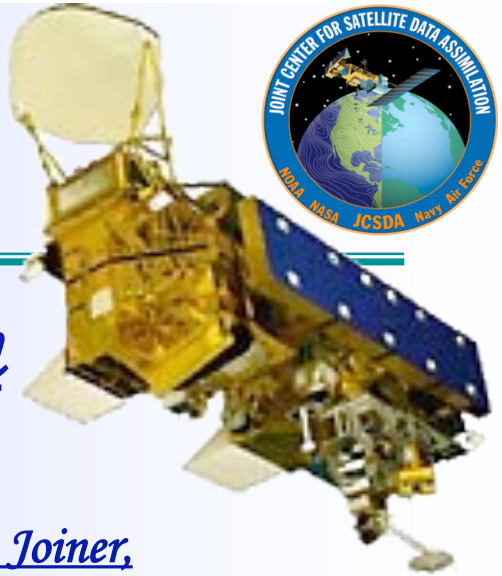
- Test period 10 Mar – 5 Apr 2004
- Uses data operational at time of experiment
- Mass storage problems on our machine, so some incomplete evaluation
- Experiments
  - Current operational
  - Current + AIRS
  - Current + AQUA AMSU
  - Current + AIRS + AQUA AMSU (underway)

AQUA



Hyperspectral Data

Assim.– Later Studies



AIRS Data Assimilation

J. Le Marshall, J. Jung, J. Derber, R. Treadon,
S.J. Lord, M. Goldberg, W. Wolf and H-S Liu, J. Joiner,
and J Woollen…… May 2004

1 January 2004 – 31 January 2004

Used operational GFS system as Control

Used Operational GFS system Plus Enhanced AIRS Processing as Experimental System

Table 1: Satellite data used operationally within the NCEP Global Forecast System

HIRS sounder radiances	TRMM precipitation rates
AMSU-A sounder radiances	ERS-2 ocean surface wind vectors
AMSU-B sounder radiances	Quikscat ocean surface wind vectors
GOES sounder radiances	AVHRR SST
GOES 9,10,12, Meteosat	AVHRR vegetation fraction
atmospheric motion vectors	AVHRR surface type
GOES precipitation rate	Multi-satellite snow cover
SSM/I ocean surface wind speeds	Multi-satellite sea ice
SSM/I precipitation rates	SBUV/2 ozone profile and total ozone

The Trials – Assim1

- Used `full AIRS data stream used (JPL)
  - NESDIS (ORA) generated BUFR files
  - All FOVs, 324(281) channels
  - 1 Jan – 15 Feb '04

- Similar assimilation methodology to that used for operations
- Operational data cut-offs used
- Additional cloud handling added to 3D Var.
- Data thinning to ensure satisfying operational time constraints

The Trials – Assim1

- Used NCEP Operational verification scheme.

AIRS Assimilation

- Used 251 Out of 281 Channels

  - 73 - 86 Removed (Channels peak too High)

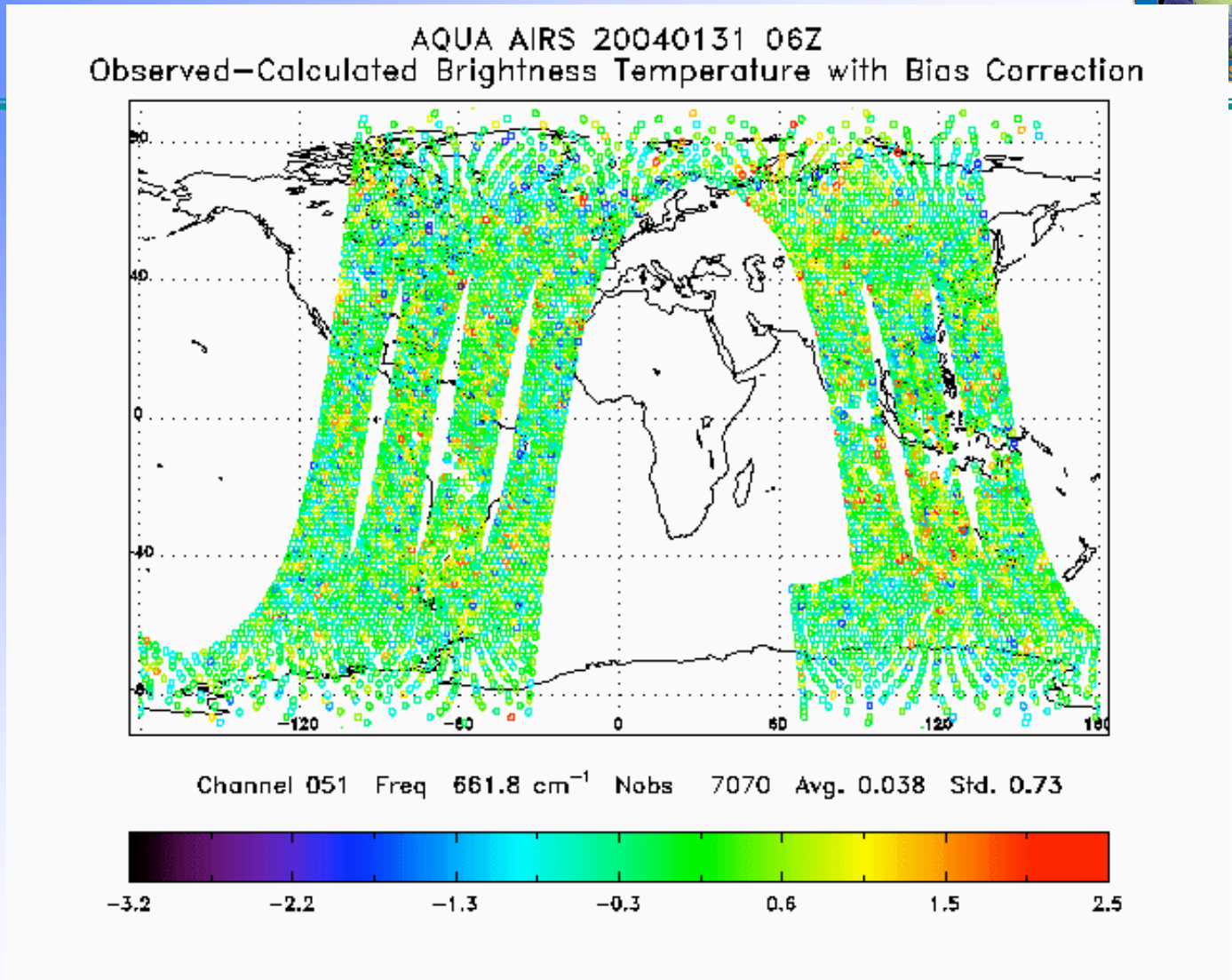
  - 1937 - 2109 Removed (Non LTE)

  - 2357 Removed (Large Obs – Background Diff.)

- Used Shortwave at Night

  – Wavenumber > 2000 cm^{-1} Downweighted

  – Wavenumber > 2400cm^{-1} Removed



AIRS data coverage at 06 UTC on 31 January 2004. (Obs-Calc. Brightness Temperatures at 661.8 cm^{-1} are shown)

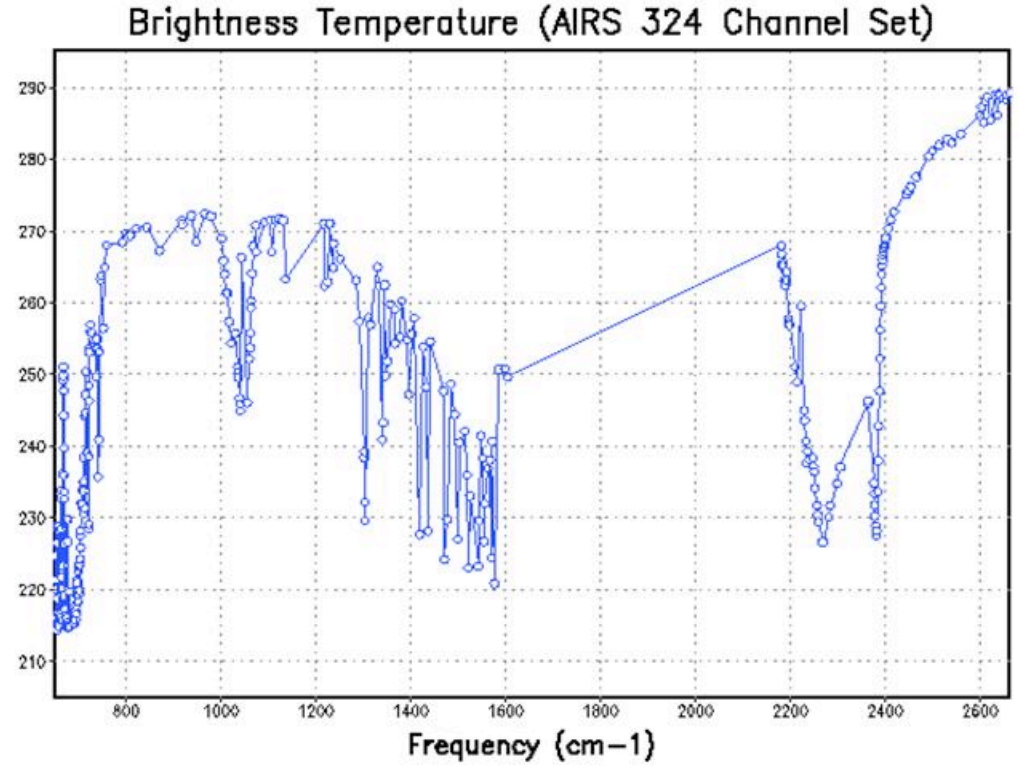


Figure 5.Spectral locations for 324 AIRS thinned channel data distributed to NWP centers.

Table 2: AIRS Data Usage per Six Hourly Analysis Cycle

Data Category	Number of AIRS Channels
Total Data Input to Analysis	~200x10^6 radiances (channels)
Data Selected for Possible Use	~2.1x10^6 radiances (channels)
Data Used in 3D VAR Analysis(Clear Radiances)	~0.85x10^6 radiances (channels)

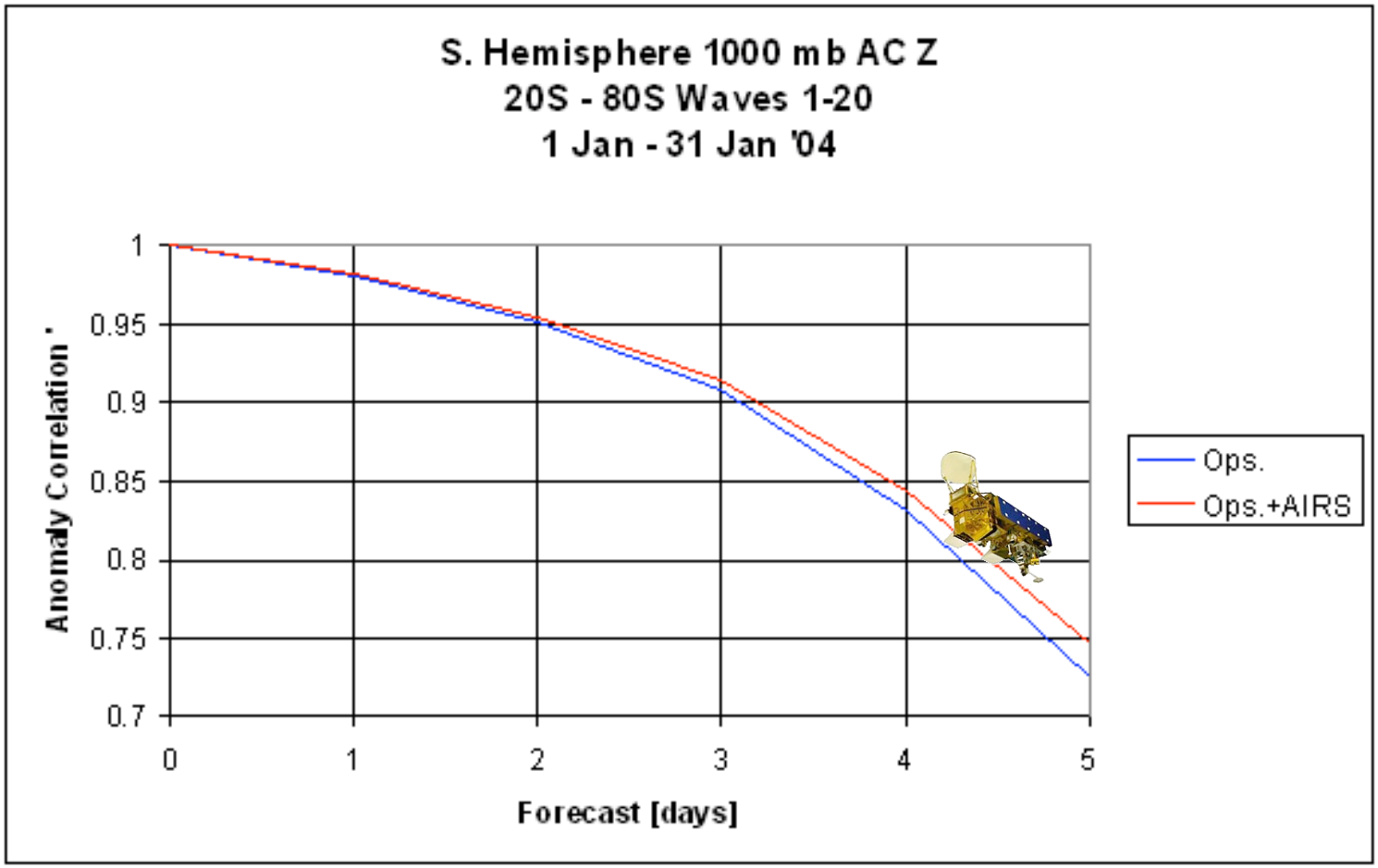
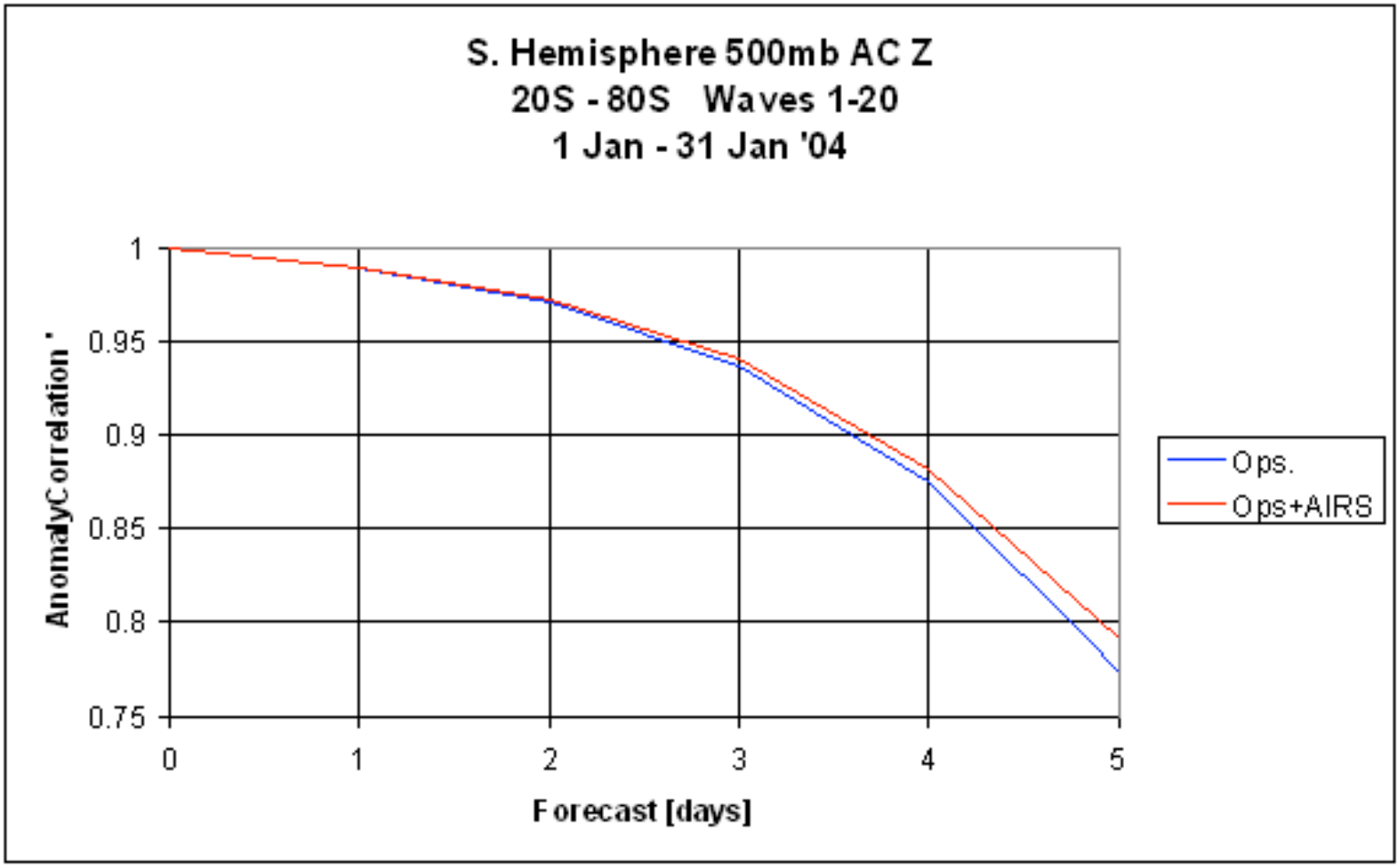


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004- Assim1



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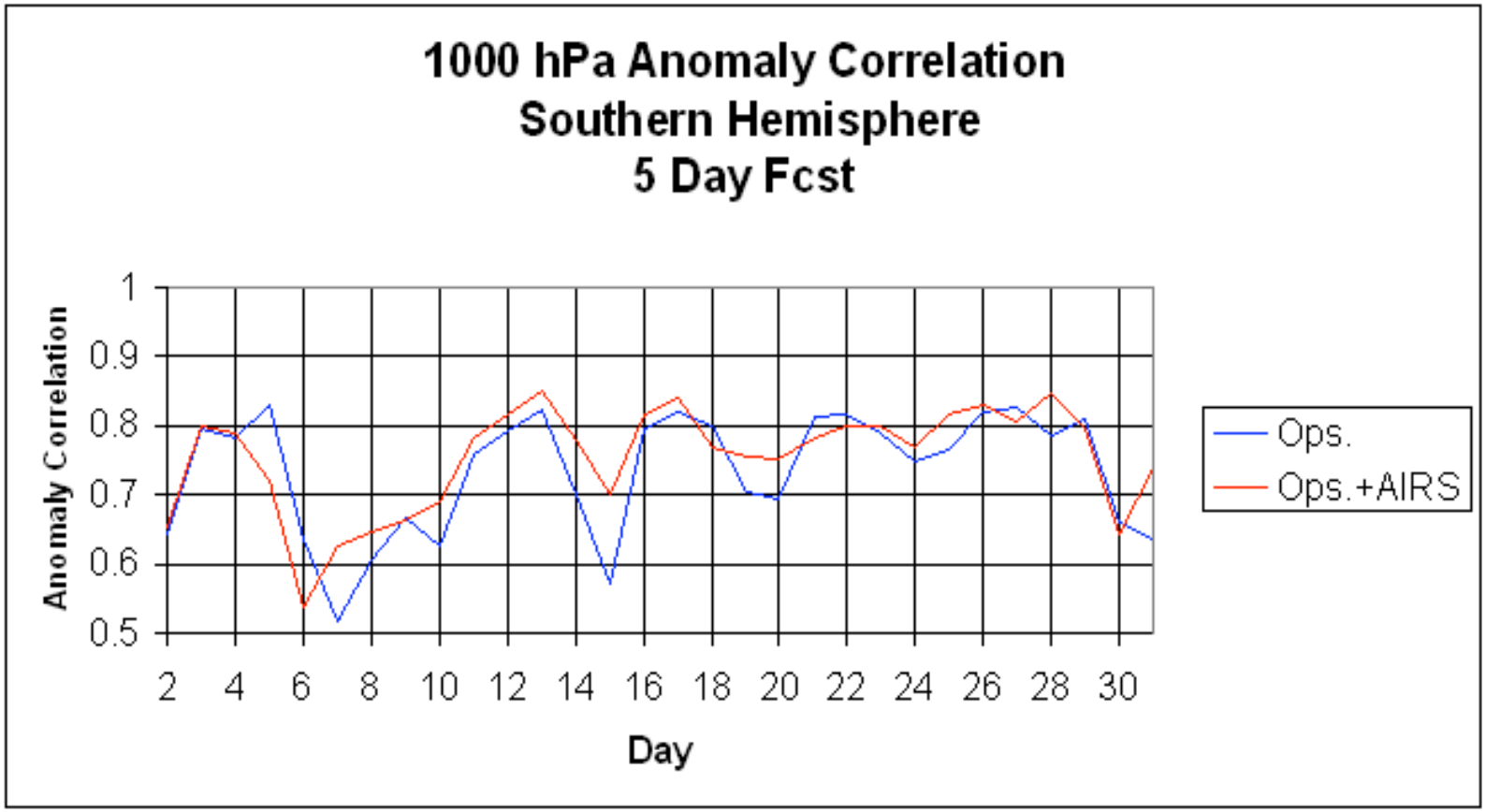


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

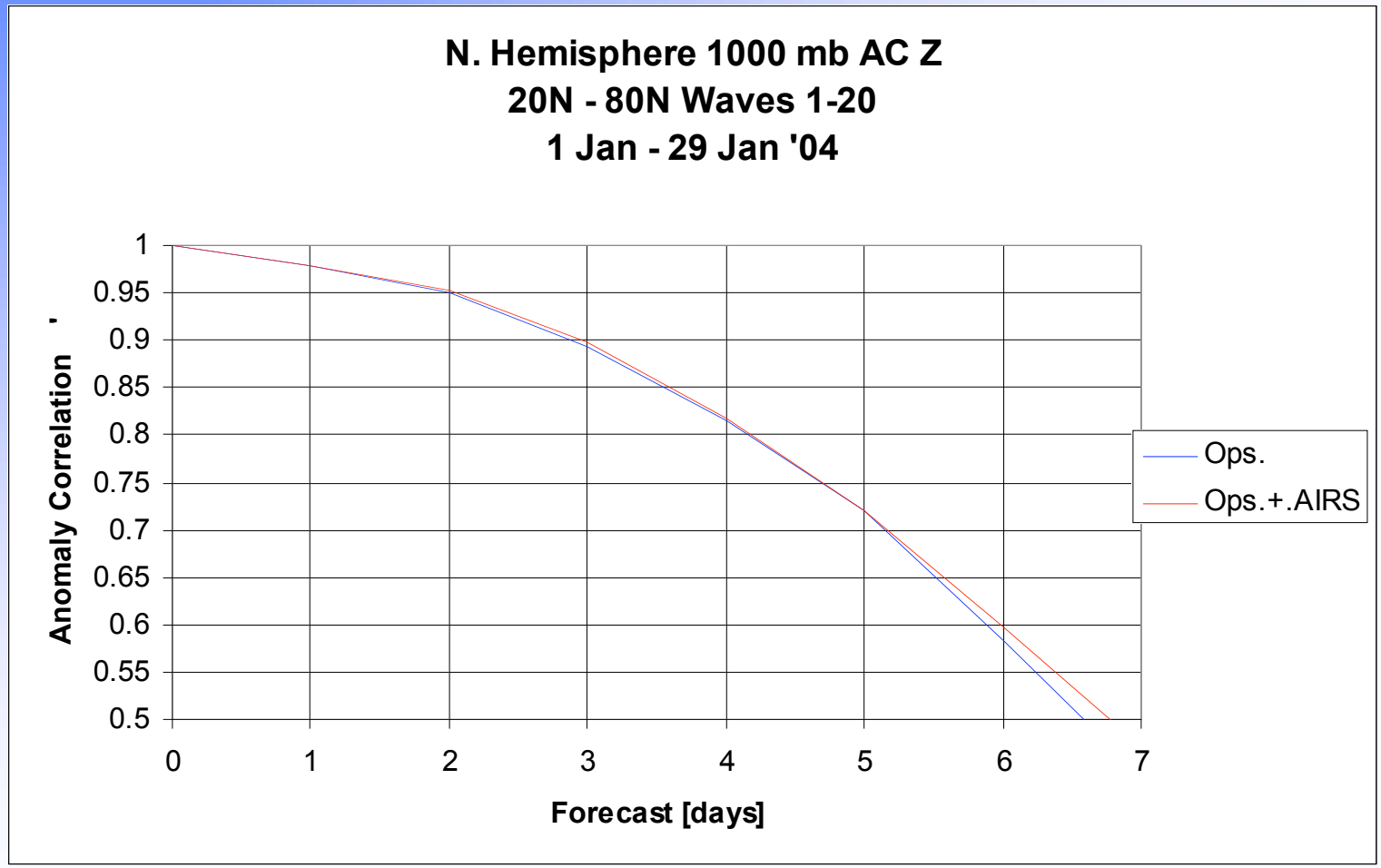


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern Hemisphere, January 2004

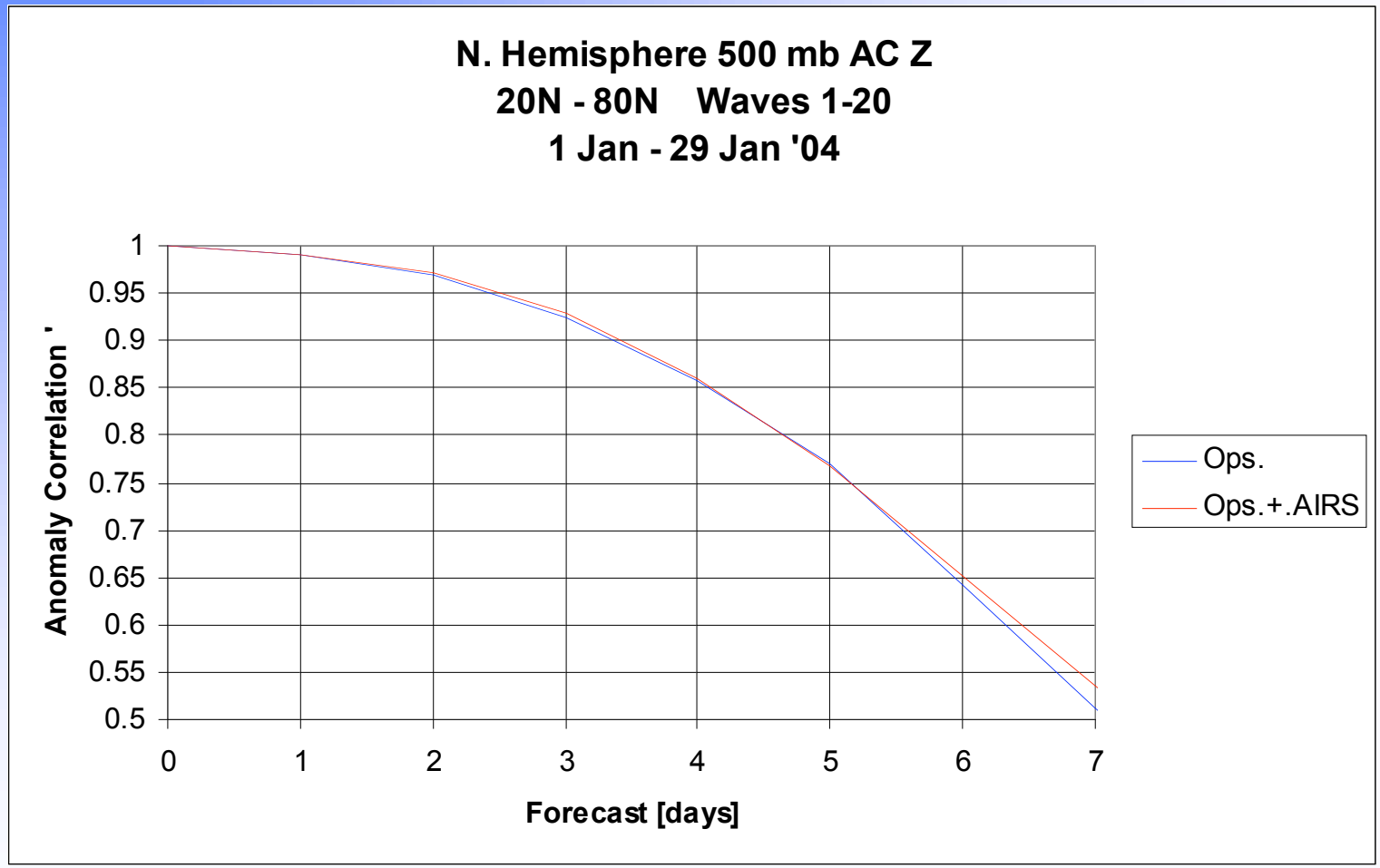
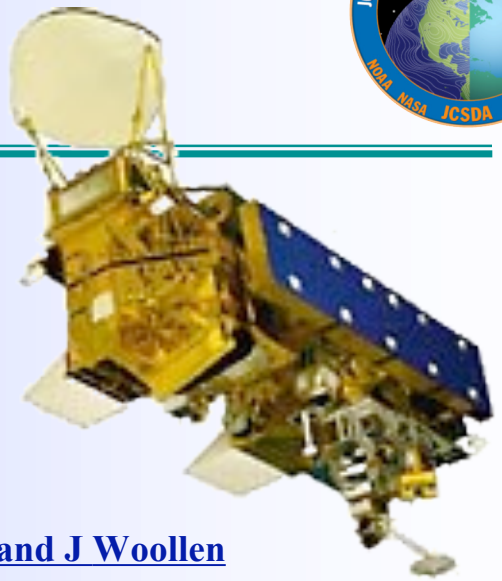


Figure1(a). 500hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern Hemisphere, January 2004



AIRS Data Assimilation

J. Le Marshall, J. Jung, J. Derber, R. Treadon, S.J. Lord,
M. Goldberg, W. Wolf and H-S Liu, J. Joiner T. Zapotocny and J Woollen

1-31 January 2004

Used operational GFS system as Control

Used Operational GFS system Plus Enhanced AIRS Processing as Experimental System

Clear Positive Impact

The Trials – Assim 2

- Used `full AIRS data stream used (JPL)
  - NESDIS (ORA) generated BUFR files
  - All FOVs, 324(281) channels
  - 1 Jan – 27 Jan '04

- Similar assimilation methodology to that used for operations
- Operational data cut-offs used
- Additional cloud handling added to 3D Var.
- Data thinning to ensure satisfying operational time constraints

The Trials – Assim 2

- AIRS related weights/noise modified
- Used NCEP Operational verification scheme.

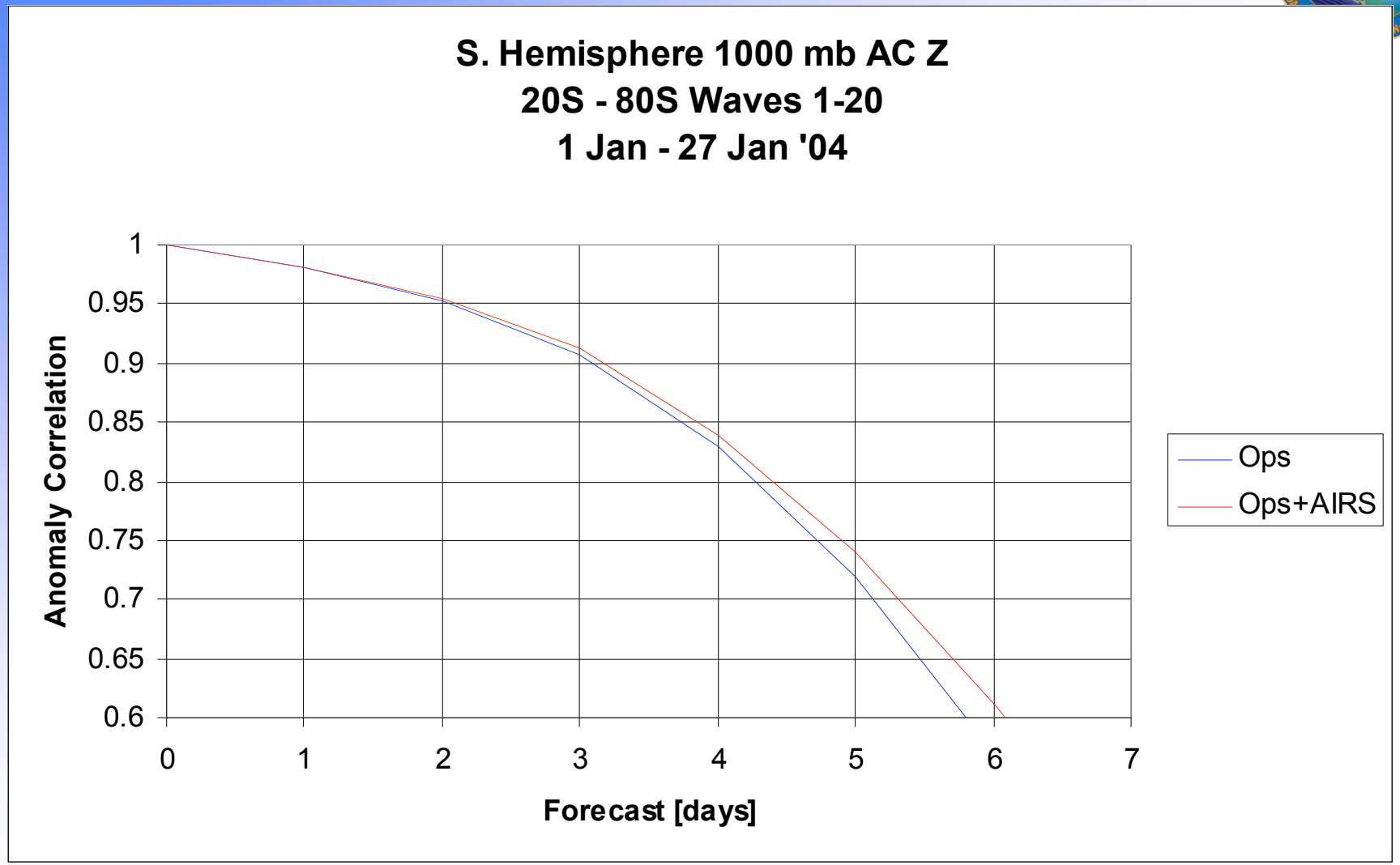


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

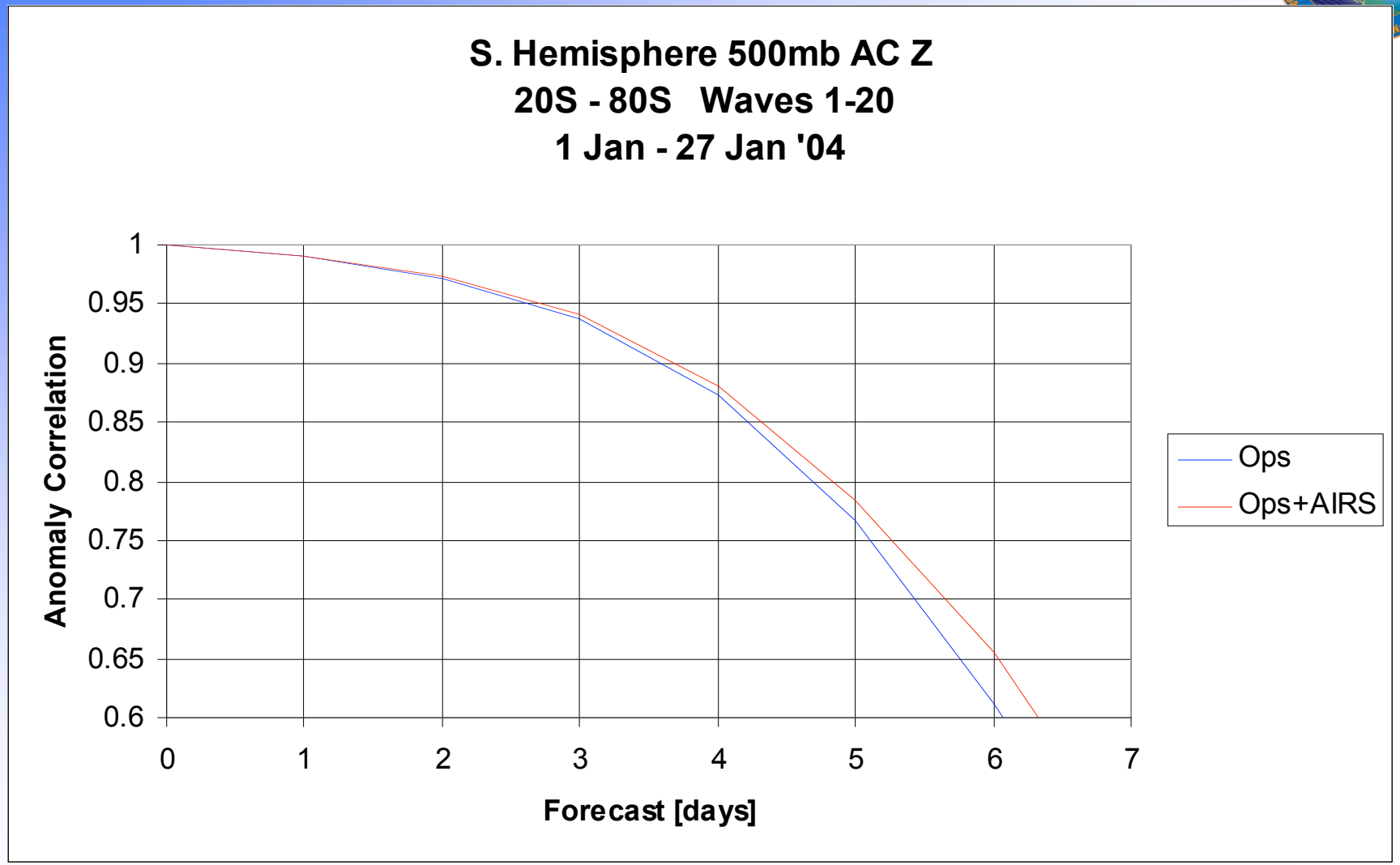


Figure 1(b). 500hPa Z Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

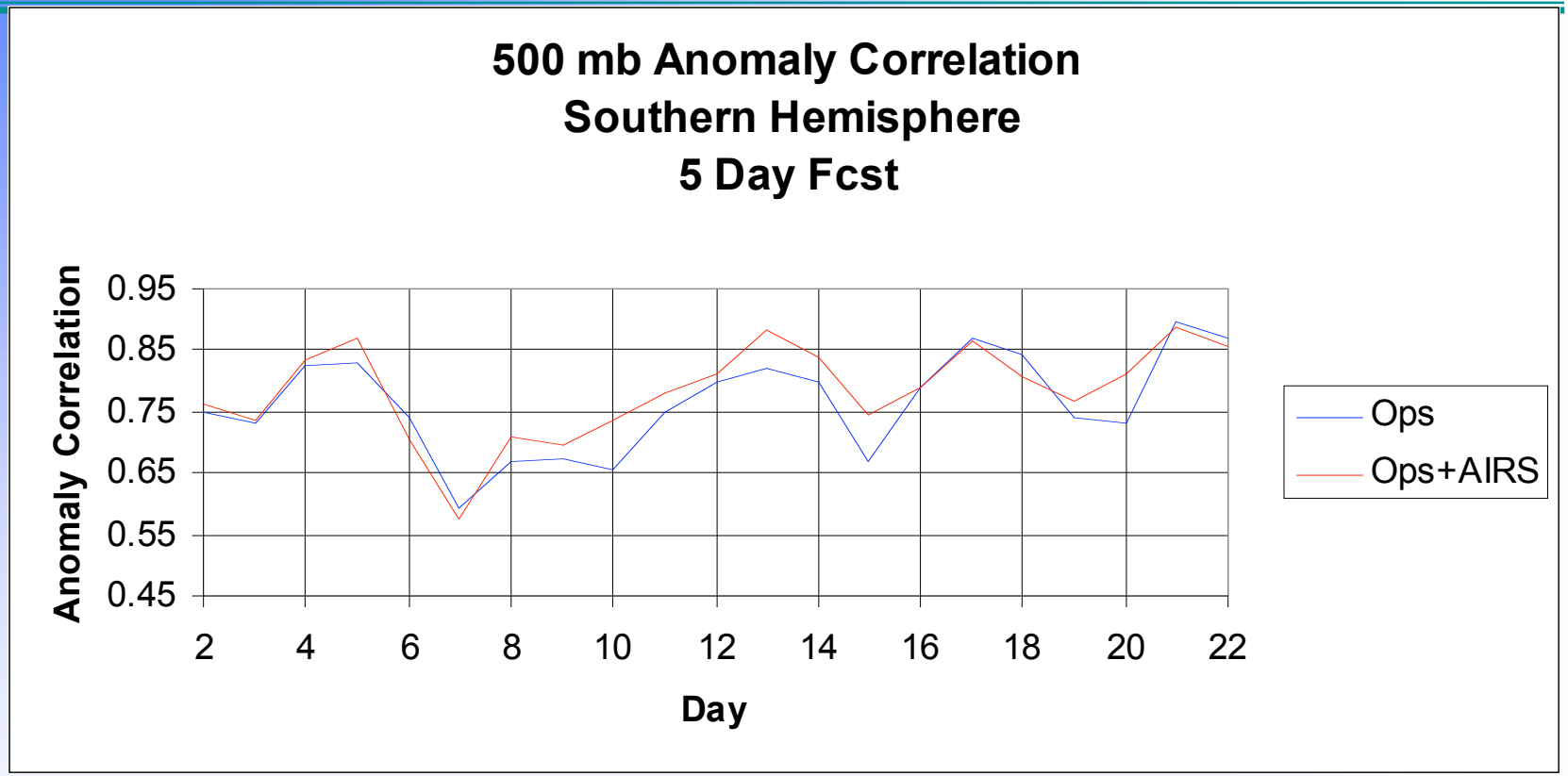


Figure 2. 500hPa Z Anomaly Correlations 5 Day Forecast for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, (1-27) January 2004

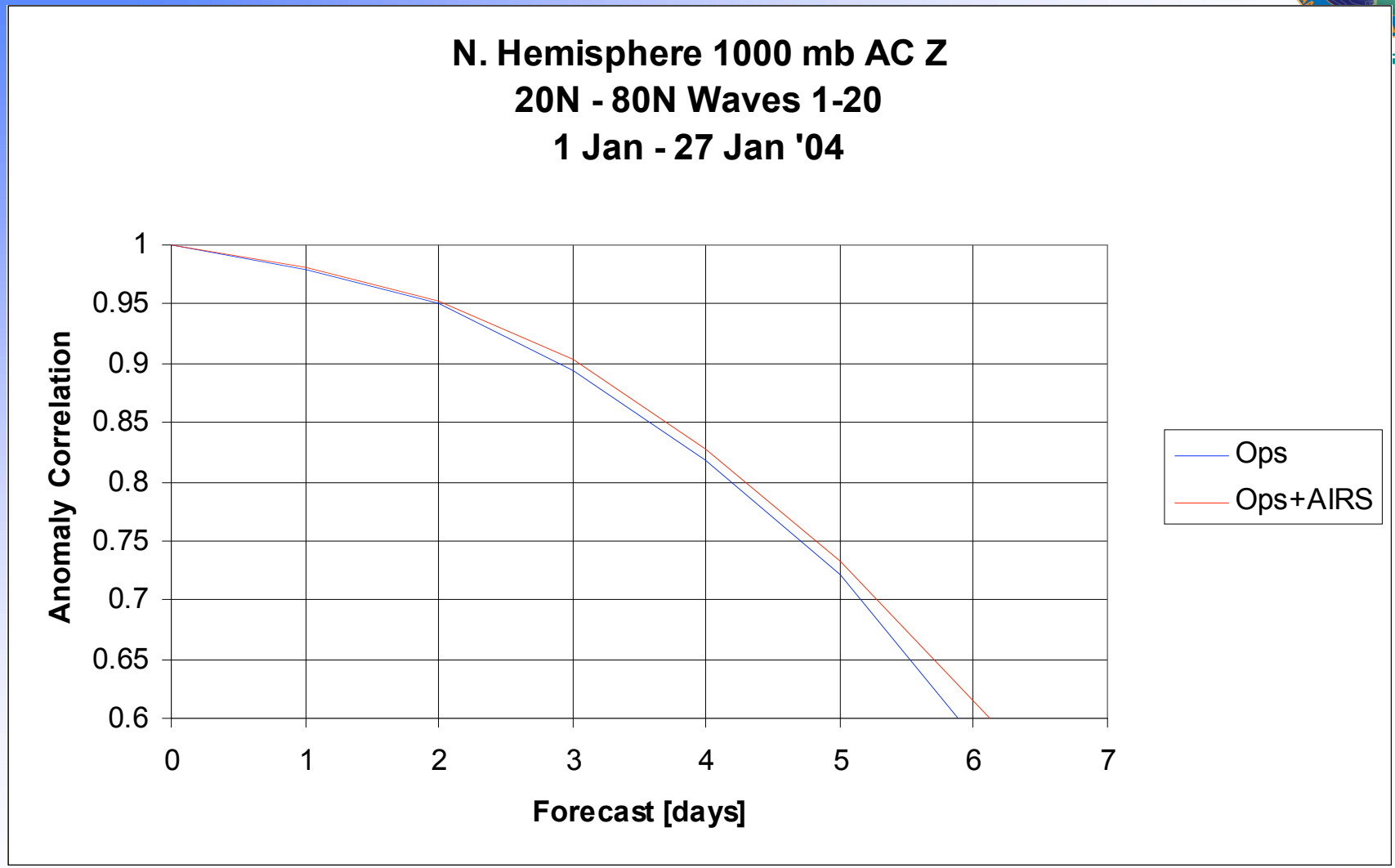


Figure3(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern hemisphere, January 2004

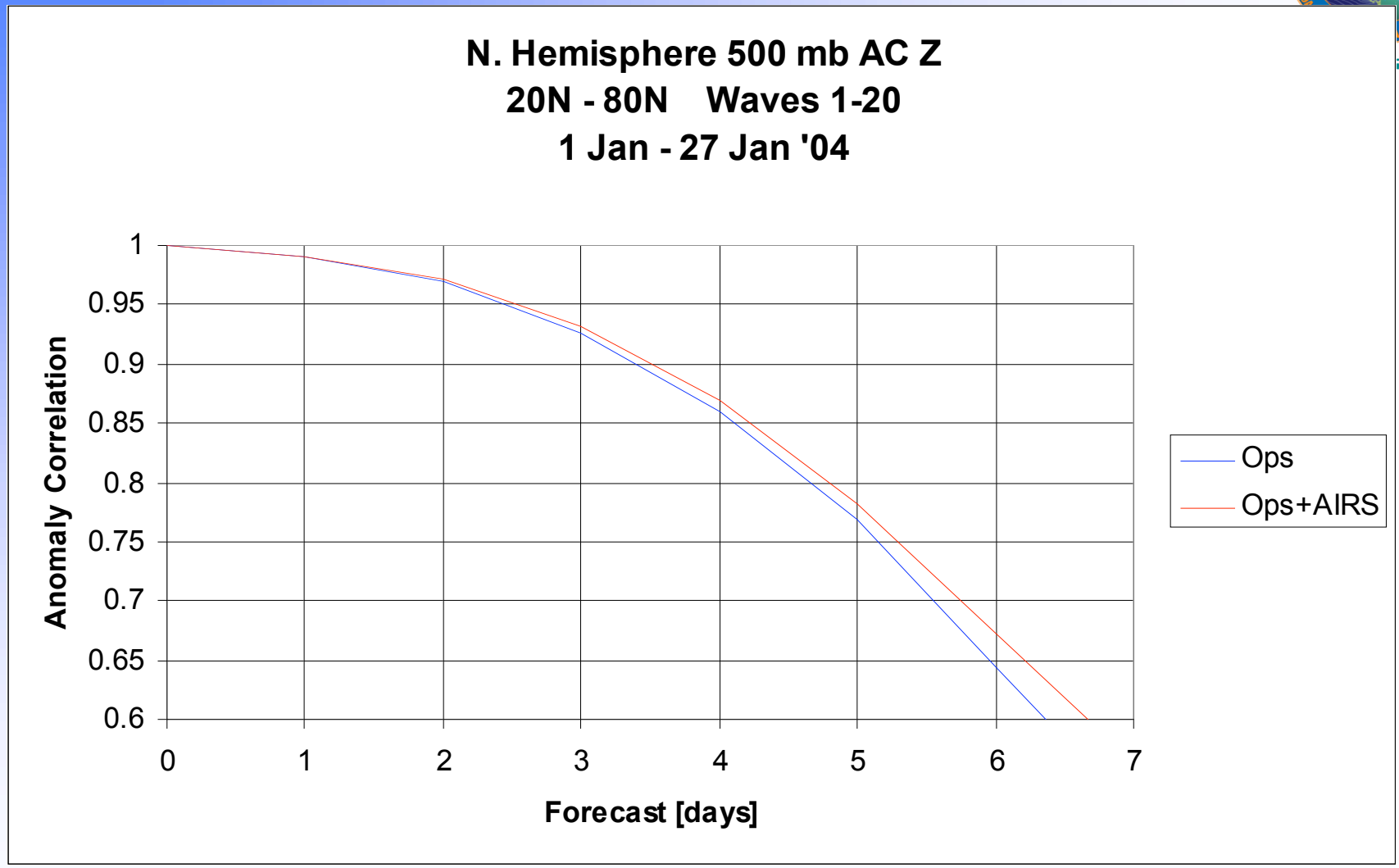


Figure 3(b). 500hPa Z Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern hemisphere, January 2004

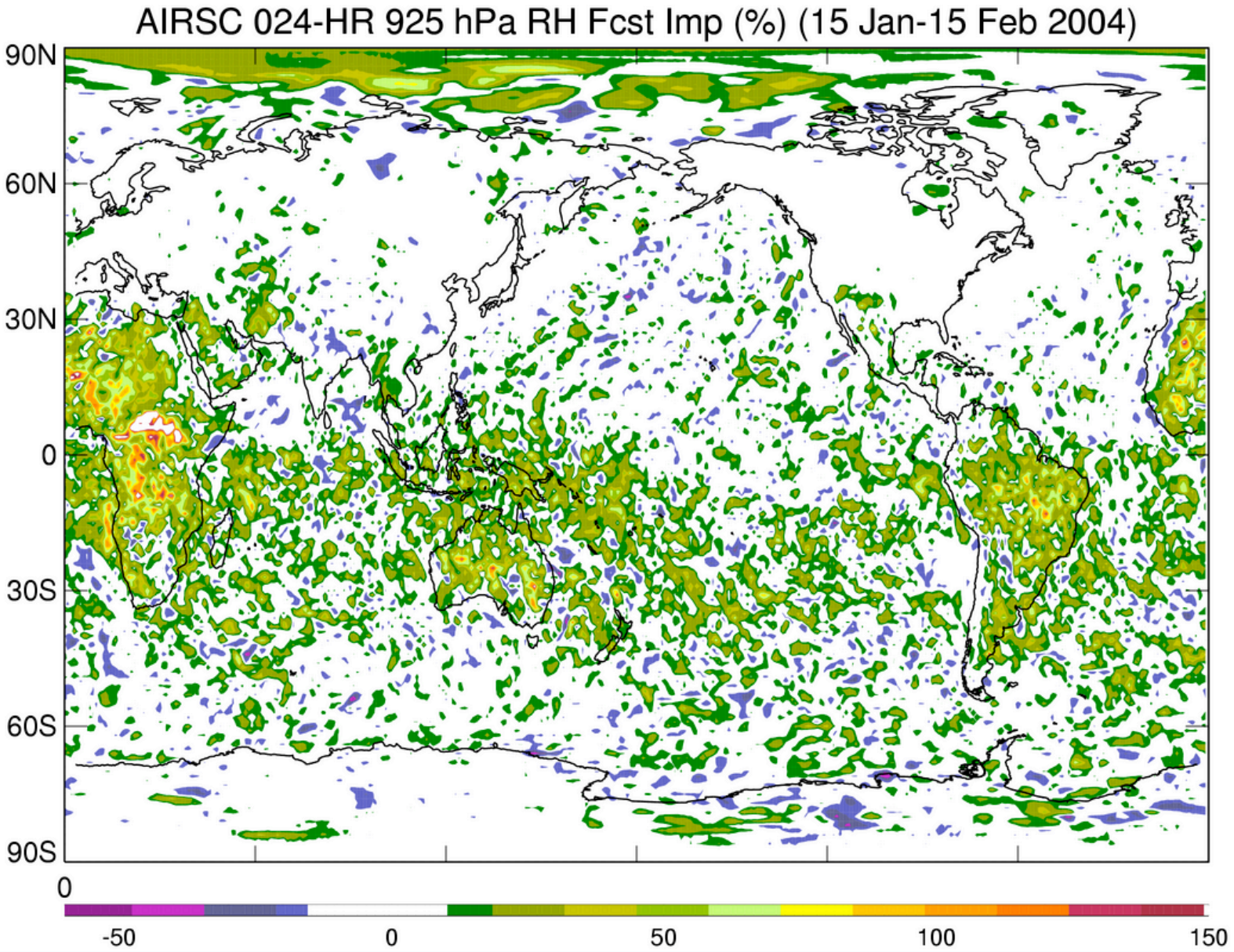
AIRS Data Assimilation

MOISTURE

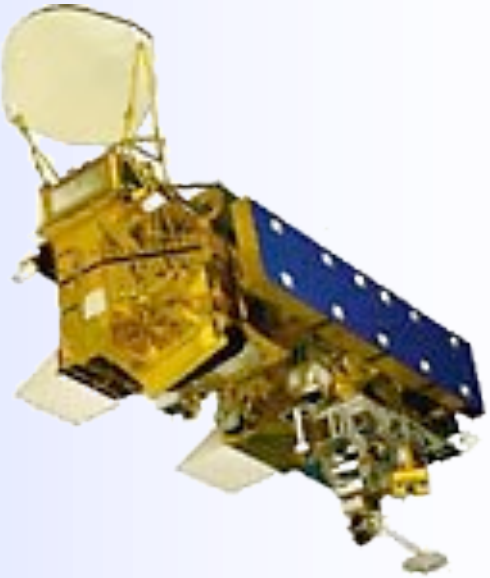
Forecast Impact evaluates which forecast (with or without AIRS) is closer to the analysis valid at the same time.

Impact = 100* [Err(Cntl) – Err(AIRS)]/Err(Cntl)

Where the first term on the right is the error in the Cntl forecast. The second term is the error in the AIRS forecast. Dividing by the error in the control forecast and multiplying by 100 normalizes the results and provides a percent improvement/degradation. A positive Forecast Impact means the forecast is better with AIRS included.



Forecast Impact improvement/degradation (%) of the 12 hr Relative Humidity forecast at 925 hPa .



AIRS Data Assimilation

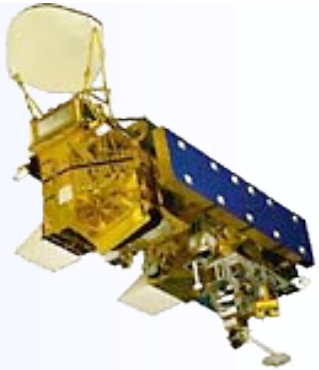
J. Le Marshall, J. Jung, J. Derber, R. Treadon, S.J. Lord,
M. Goldberg, W. Wolf and H-S Liu, J. Joiner and J Woollen

January 2004

Used operational GFS system as Control

Used Operational GFS system Plus Enhanced AIRS Processing as Experimental System

Clear Positive Impact Both Hemispheres



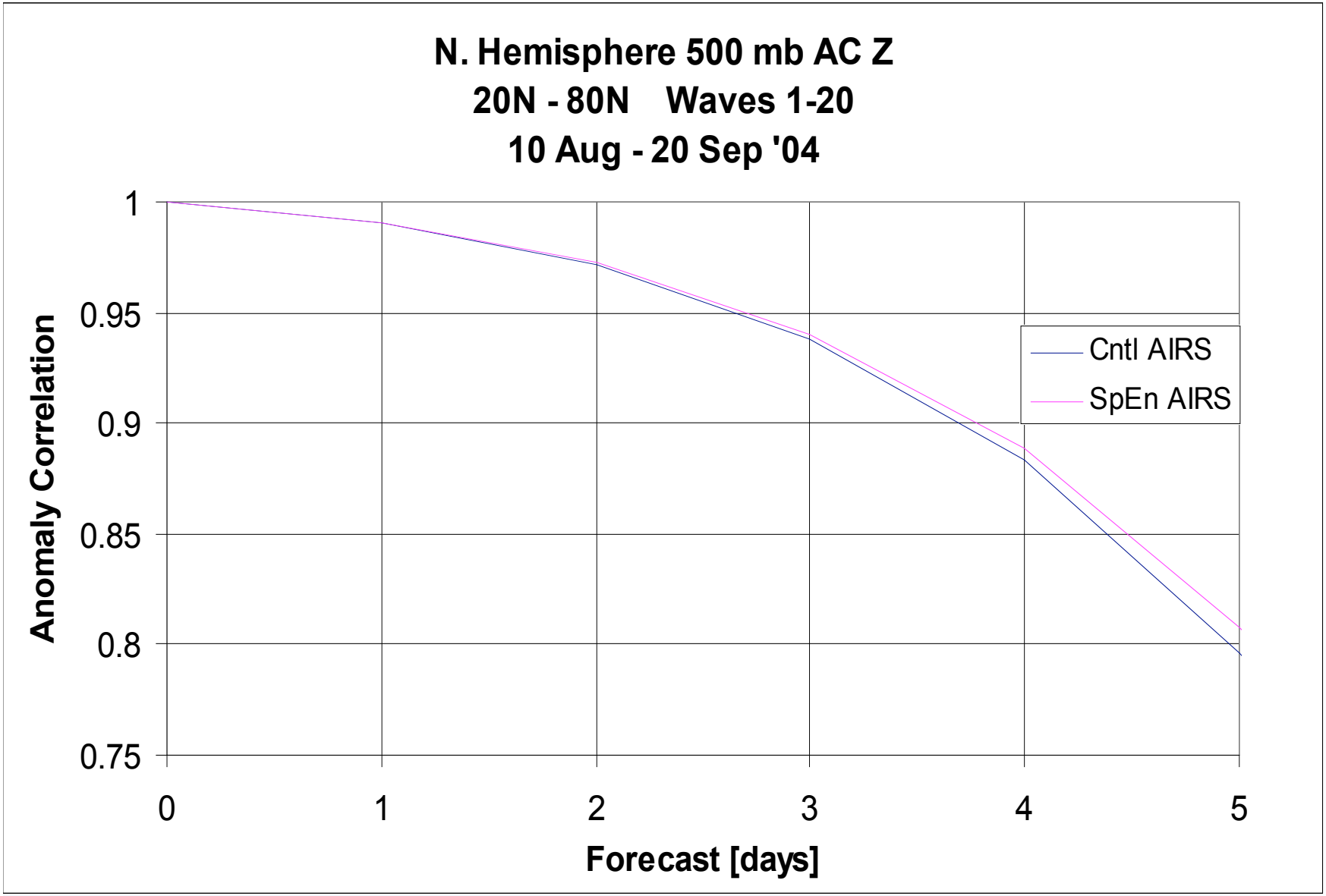
AIRS Data Assimilation

Impact of Data density...

10 August – 20 September 2004

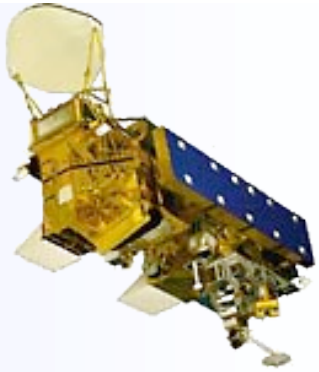
GFS Version June 2004 (T2540)

AQUA AMSU-A in Control data base



Impact of AIRS spatial data density

500hPa Z Anomaly Correlations for the GFS with current thinned – one AIRS fov in 18 (Cntl AIRS) and for the GFS using all AIRS fovs (SpEn AIRS), Northern Hemisphere, August/September, 2004



AIRS Data Assimilation

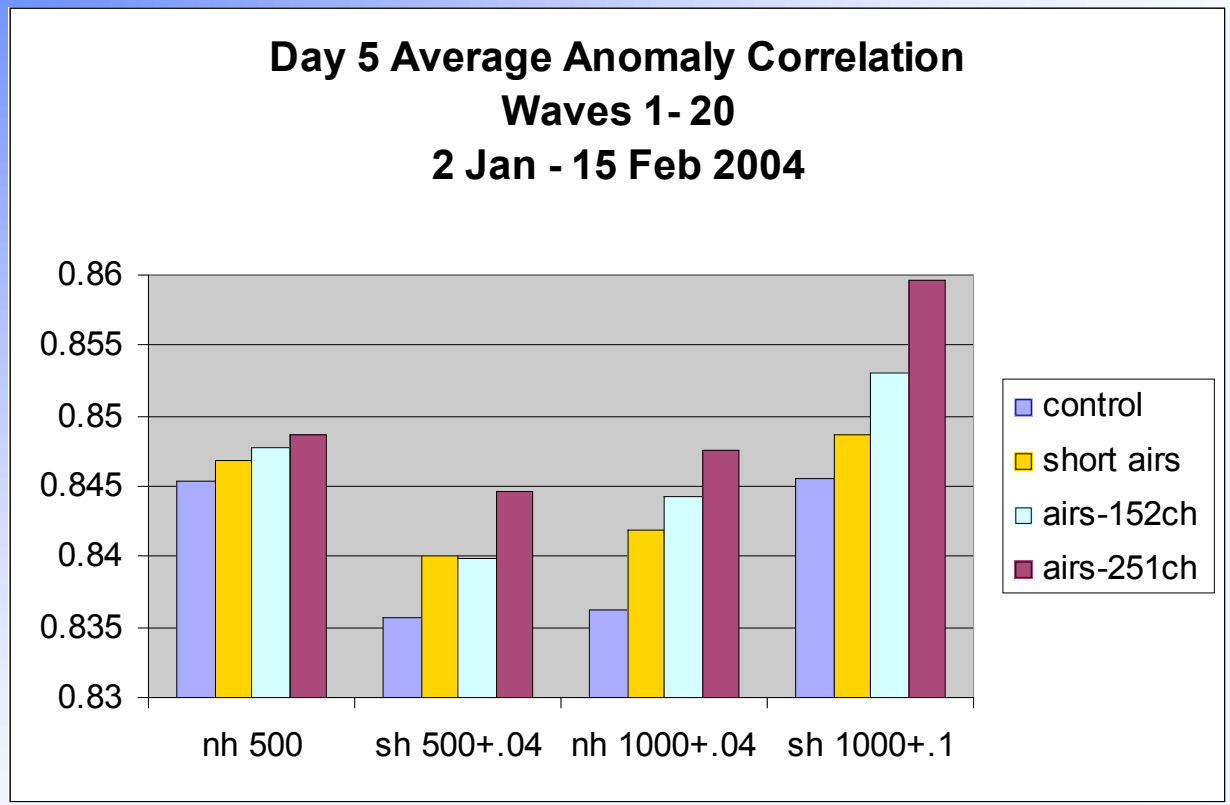
Impact of Spectral Coverage

10 January – 15 February 2004

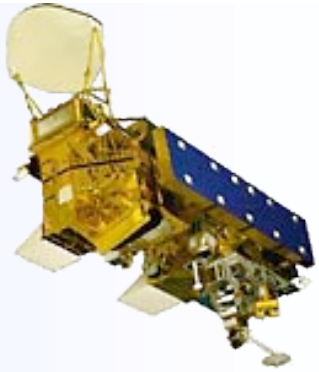
GFS Version June 2005 (T254)

AQUA AMSU-A in Control data base

Impact of Spectral Coverage



1000 and 500hPa Z Anomaly Correlations for the GFS for the Control, Short (using 115 AIRS shortwave channels), airs-152ch using 152 out of the 281 channels available for real time NWP and airs-251ch using 251 out of the 281 channels available for real time NWP, Northern and Southern Hemisphere, January/February, 2004



AIRS Data Assimilation

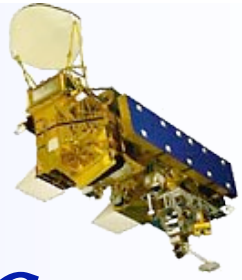
Impact of Spatial & Spectral Coverage

Dec. 05 – Jan 06

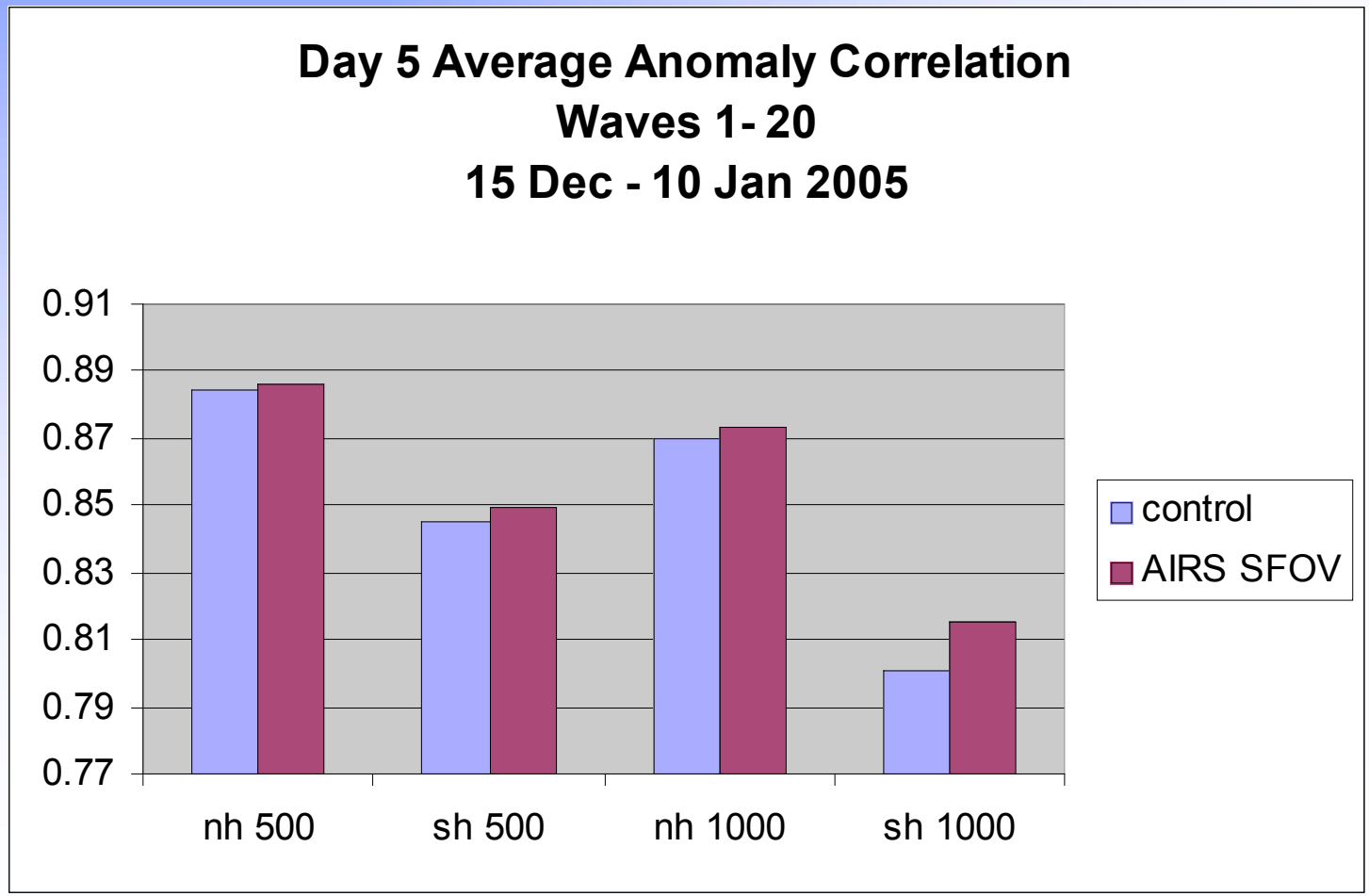
GFS Version Jan. 2005 (T382)

AQUA AMSU-A in Control data base

AIRS Data Assimilation



Impact of Spatial & Spectral Coverage



AIRS – *Work Underway*

Fast Radiative Transfer Modelling (OSS, Superfast RTM)

RISK REDUCTION / OSSEs :

AIRS

AIRS – SW/LW Comparison (GOES-R related study)

AIRS – SW/MW/LW Comparison (NPOESS/GOES-R related study)

GFS Assimilation studies using:

full spatial/spectral resolution AIRS data with surface €.

full spatial resolution AIRS/MODIS Assim.

full spatial res. AIRS with Cloud Cleared Radiances.

full spectral res. AIRS

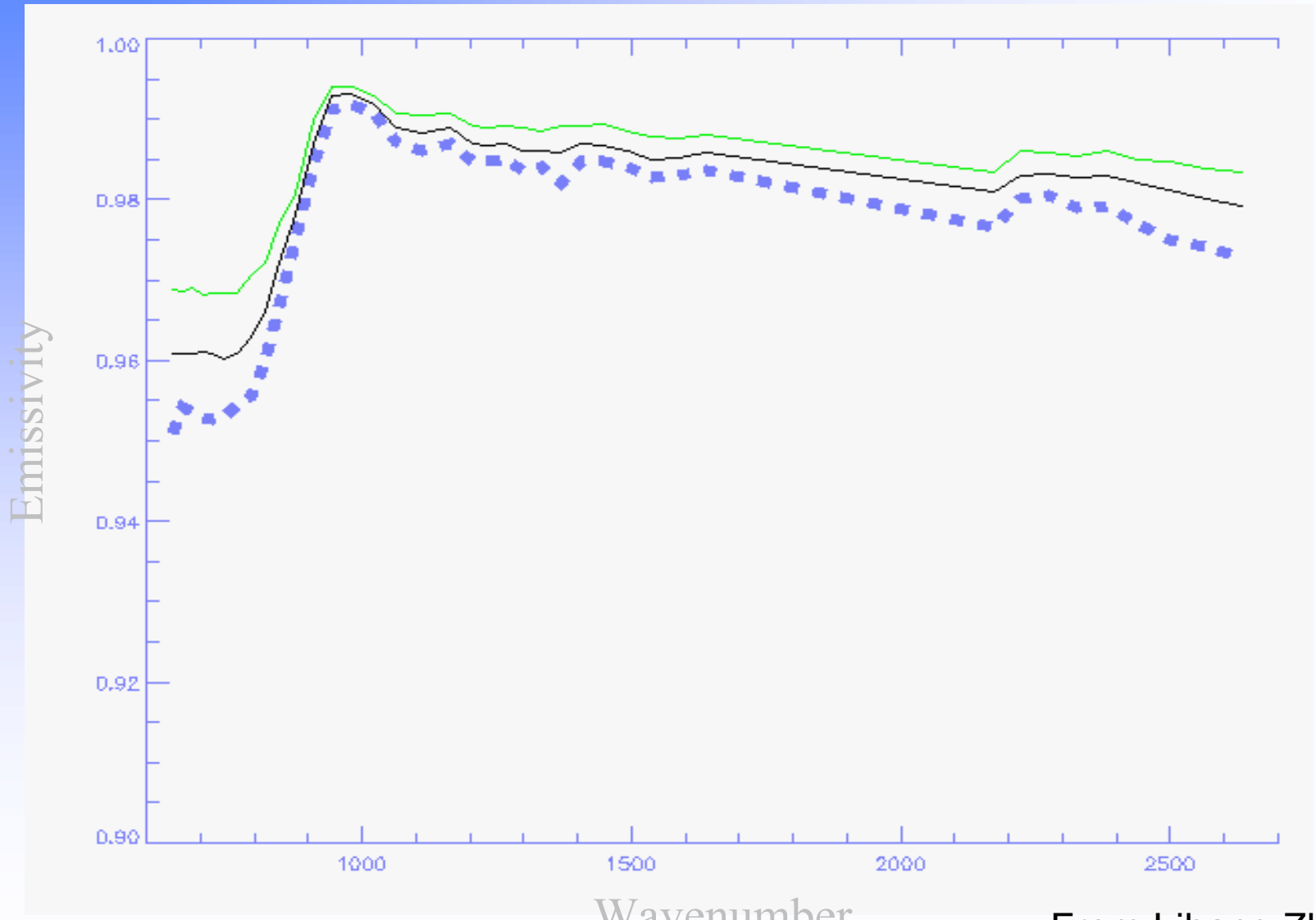
Surface Emissivity (ε) Estimation Methods

- Geographic Look Up Tables (LUTs)
- Regression based on theoretical estimates
- Minimum Variance, provides T_{surf} and ε
- Eigenvector technique

- Variational Minimisation – optimal

IR HYPERSPECTRAL EMISSIVITY - ICE and SNOW

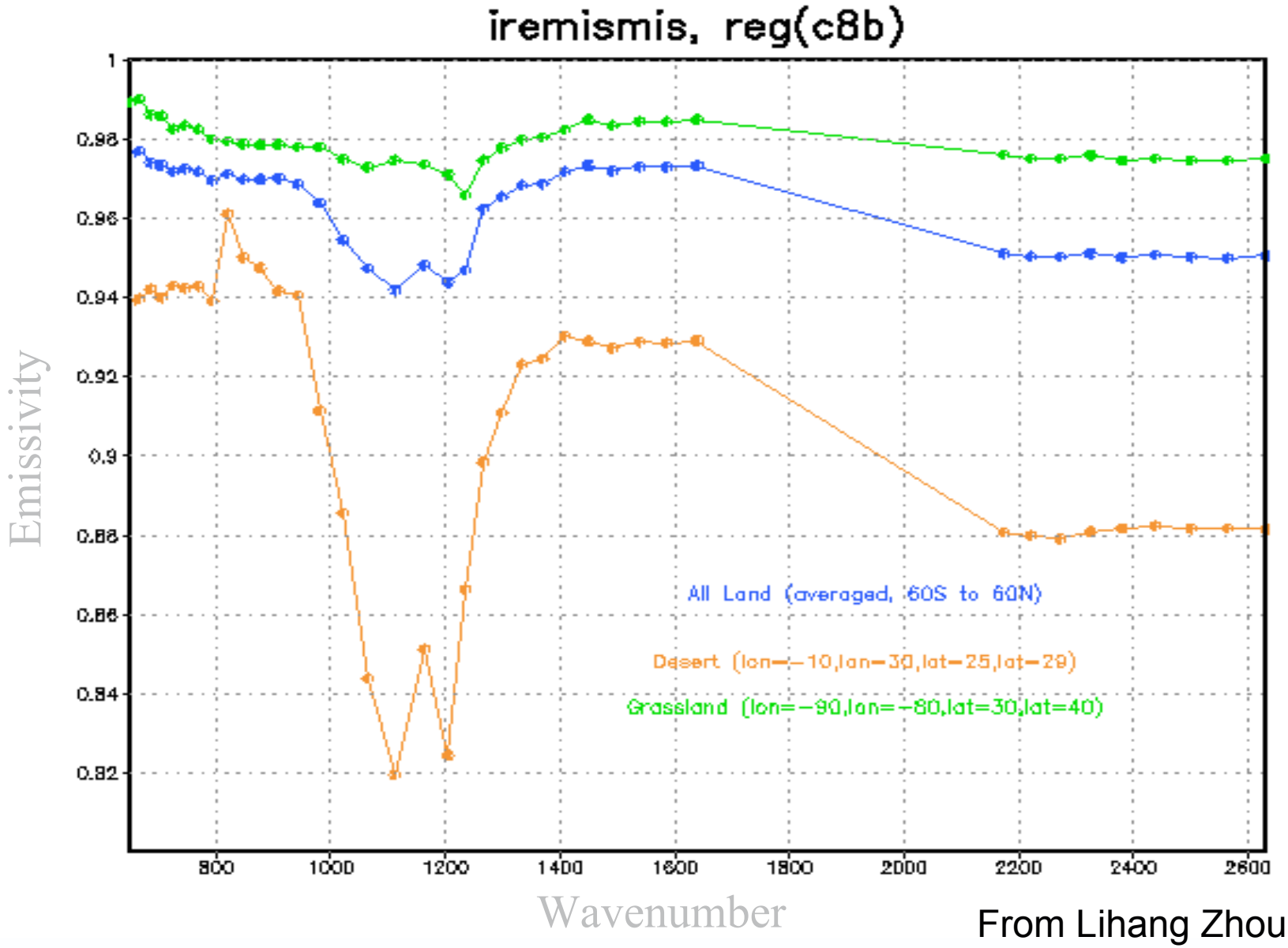
Sample Max/Min Mean computed from synthetic radiance sample



From Lihang Zhou

IR HYPERSPECTRAL EMISSIVITY - LAND

Sample Max/Min Mean computed from synthetic radiance sample



From Lihang Zhou

JCSDA AIRS Data Assimilation

Summary:

AIRS data has been examined at different spatial densities, spectral composition and with different error covariances

First significant impact (N & S Hemispheres) used full spatial density data and appropriate error covariances

Clear indication of positive impact in presence of full operational data base has been demonstrated

and AIRS is in operational use.

Benefit of fuller spectral/spatial coverage demonstrated

Significant areas for improvement remain and will provide additional gains


JOINT CENTER FOR SATELLITE DATA ASSIMILATION
NOAA NASA JCSDA Navy Air Force